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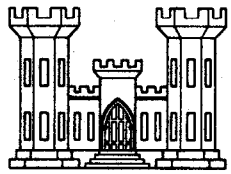

COLONIAL BIRDS NESTING ON MAN-MADE AND NATURAL SITES IN THE U. S. GREAT LAKES

by

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number):

Habitats and nesting populations of colonial nesting birds of the U. S. Great Lakes were determined by aerial census, ground nest observations, and vegetation analysis during 1976 and 1977. Thirteen species at 267 colonies were found during this 2-year study. An atlas of nesting sites and populations for both years of the study locates and gives the sizes of the colonies. Intensive vegetation and habitat studies were performed on 24 sites: 8 natural

(Continued)

20. ABSTRACT (Continued)

islands and 16 dredged material locations. A greater percentage of cover by herbaceous vegetation was favored by ring-billed gulls and herring gulls, but common and Caspian terns preferred less vegetative cover. Both ciconiiform and larid colonial nesters killed or badly stressed the vegetation supporting, surrounding, and/or below their nests. Soil analyses showed high levels of macronutrients in most colonies except those of Caspian and common terns. These nutrients were presumed to be toxic except to a few adapted plant species frequently found in heavily fertilized ring-billed gull colonies. The drop in Great Lakes water levels in 1977 produced new nesting sites and more nesting area. New colonies frequently had retarded nesting in relation to other colonies and lessened intracolony synchrony, nest density, and nesting success. This was regardless of whether the site was natural or dredged material in origin.

Colony size and previous experience of the breeders seemed more important than latitude in determining date of peak hatching and chronological sequence of nesting in ring-billed gulls. The water table at the site affected nesting success by changing vegetation from hydric to xeric seres. In the case of standing impounded water, it could be drained or dewatered to provide additional nesting space. Effective dewatering practices are important to the construction of dredged material sites where colonial nesting birds are desired. Other management considerations important for encouragement or discouragement of colonial bird use are the proximity and attractiveness to humans allowing intrusions, proximity to an aircraft hazard zone, prevention of access by predators, height of dikes, and initial cover seeding or plant establishment.

Appendix A presents maps of the colonies in the study. Appendix B lists common and scientific names of plants discussed in this report. Appendix C gives the relative density, coverage, and frequency of plants in the sample area. Appendixes D and E discuss the colonial nesting surveys in the St. Marys River area and the Beaver Islands archipelago, respectively.

THE CONTENTS OF THIS REPORT ARE NOT TO BE USED FOR ADVERTISING, PUBLICATION, OR PROMOTIONAL PURPOSES. CITATION OF TRADE NAMES DOES NOT CONSTITUTE AN OFFICIAL ENDORSEMENT OR APPROVAL OF THE USE OF SUCH COMMERCIAL PRODUCTS.

PREFACE

The study reported herein was conducted by Northwestern Michigan College, Traverse City, Mich., during 1976-1977. The study was jointly sponsored by the Office, Chief of Engineers, U. S. Army (OCE), and the U. S. Fish and Wildlife Service (USFWS), under Contract No. USFWS-CE7-255. The study was monitored by the Environmental Laboratory (EL), U. S. Army Engineer Waterways Experiment Station (WES), Vicksburg, Miss., and by the USFWS Office of Biological Services, National Coastal Ecosystems Team, NSTL Station, Miss.

USFWS participation in the study was under the Coastal Ecosystems Project of the Biological Services Program. WES participation was part of the Dredged Material Research Program (DMRP), sponsored by OCE and managed by EL, and constituted DMRP Work Unit No. 4F01A.

Dr. William C. Scharf and Messrs. Gary W. Shugart and Michael L. Chamberlin conducted the study. Dr. Scharf wrote the first and second drafts of the final report with the exception of Appendix A, which was prepared by USFWS and WES, and Appendixes D and E, which were written by Messrs. Chamberlin and Shugart, respectively. Ms. Mary C. Landin (WES) wrote the final draft. The text and some appendix figures were also prepared by WES.

Ms. Landin was Contract Manager and Mr. Larry Shanks (USFWS) was Project Officer. Dr. Robert F. Soots, Jr. (WES), served as a technical advisor. WES technical review was provided by Ms. Landin, Dr. Soots, Dr. R. T. Huffman, and Ms. L. J. Hunt. FWS technical review was provided by Mr. Shanks, Dr. David Smith, and Dr. Donald Woodard. Drs. H. K. Smith (WES) and Howard Tait (USFWS) provided general supervision.

During the conduct of the study and preparation of the report COL G. H. Hilt, CE, and COL J. L. Cannon, CE, were Directors of WES. Technical Director was Mr. F. R. Brown, and Dr. John Harrison was Chief of EL.

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COLONIAL BIRDS NESTING ON MAN-MADE AND NATURAL SITES OF THE U. S. GREAT LAKES

PART I: INTRODUCTION

1. Alteration of natural habitats due to recreation, urban expansion, dredging and filling, industrial activities, and changing water levels has caused displacement of colonial nesting birds in some areas and encouraged population growths in others. The purpose of this report is to document the habitat relationships at 24 selected natural and dredged material colonial bird nesting sites and to identify the species and population sizes of all colonial nesting birds of the U. S. Great Lakes up to 1.6 km inland. The following species of birds are included in this study: double-crested cormorant, Phalcrocorax auritus; great blue heron, Ardea herodias; cattle egret, Bubulcus ibis; great egret, Casmerodius albus; snowy egret, Egretta thula; black-crowned night heron, Nycticorax nycticorax; herring gull, Larus argentatus; ring-billed gull, Larus delawarensis; Forster's tern, Sterna forsteri; common tern, Sterna hirundo; Caspian tern, Sterna caspia; and black tern, Chilodonias niger. Little gull (Larus minutus) was observed as a first recorded nesting species in the Great Lakes during this study.

2. An interim report of this study (Scharf et al. in press) described the 1976 population status and the apparent relationship between vegetation and populations of colonial nesting species. This report concentrates on more detailed vegetation analysis of habitats and includes both 1976 and 1977 nesting populations. Such vegetation study has been done only at specific sites in the U. S. Great Lakes by Hoffman and Prince (1975) and Shugart (1976). Detailed studies of the vegetation habitat of colonial nesting birds elsewhere have been made by Bongiorno (1970), Weselow and Brown (1971), Soots and Parnell (1975) and others. Other accounts of colonial nesting bird populations of the Great Lakes are found in Ludwig (1962), Scharf (1971a), and for the Canadian portion of Lake Ontario in Blokpoel (1977).

PART II: MATERIALS AND METHODS

The Study Area

3. The study area included the shore and islands of the U. S. Great Lakes extending from Pigeon Point, Minnesota to Cape Vincent, New York. It extended nearly 1280 km from east to west and 840 km from north to south. The Great Lakes are located between 40^{o} and 48^{o} north latitude and 76^{o} and 94^{o} west latitude. They are composed of a series of five of the largest freshwater bodies in the world. Fluctuations in Great Lakes water levels have historically affected the land area available for colonial nesting birds and during this study the levels of Lakes Michigan and Superior varied from record high levels to average, a fluctuation of 60 cm (Monthly Bulletin and Lake Levels, U. S. Army Engineer District, Detroit, June, 1977).

Selection of Comparison Sites

4. After the initial 1976 population and site location survey, Ms. Mary C. Landin, U. S. Army Engineer Waterways Experiment Station (WES), Mr. Larry Shanks, U. S. Fish and Wildlife Service (USFWS), and the principal investigator met and chose 24 colony sites for intensive habitat analysis in 1977. These sites were chosen for their diversity of bird species, wide geographic location, and potential for comparison between natural and man-made origins. The sites included six ring-billed gull colonies, three common tern colonies, two herring gull colonies, one herring gull/ring-billed gull association, six common tern/ring-billed gull associations, one ring-billed gull/common tern/Caspian tern association, one herring gull/Caspian tern association, one black-crowned night heron/herring gull/ring-billed gull/double-crested comorant association, one black-crowned night heron/great blue heron/great egret association, and one black-crowned night heron/cattle egret association. Geographically, the sites were located as follows: two in Lake Superior; six in the St. Marys River; two in Green Bay, Lake

Michigan; five in northern Lake Michigan; two in Saginaw Bay, Lake Huron; two in the Detroit River; two in Lake Erie; and one in Lake Ontario. Sixteen of the intensive study sites were man-made by various dredging or construction processes, and seven were natural islands.

Study of Bird Colonies

5. In additional to the study of known colonies of long standing, an aerial survey search was conducted each season with a Cessna 180 floatplane, which also enabled landing for making nest counts, gathering chronological information, assessing nest success, and sampling vegetation. Some colonies such as small great blue heron, herring gull, or common tern sites could be counted from the air. Populations at other sites were determined by transects of a portion of the colony projected on the total area, total nest counts, or grid sampling of enlarged aerial photographs (detailed descriptions in Scharf et al. in press). Information on populations and nesting was recorded and filed with the Colonial Bird Registry, Cornell University, Ithaca, New York.

Study of Vegetation

6. A transect line was established through the representative vegetation types of a nesting site. In cases where one transect was not adequate to include all the different species present or the colony was too large for a single transect, several transects were used. Plants were identified and counted, and percent coverage was determined in quadrats along the transect lines. This information was used to calculate relative frequency, relative coverage, and relative density (microfiche Appendix C), from which importance values were calculated. Herbaceous vegetation was sampled in 1 m^2 quadrats at 1 m intervals. Shrubs were sampled in 16 m^2 (4 x 4 m) quadrats at 4 m intervals. Where shrubs occurred among herbs, the shrub samples were not contiguous, but spaced according to shrub distribution. The larger shrub quadrats were used only when it was subjectively determined that shrubs were present. Trees were sampled on 100 m^2 (10 x 10 m) quadrats, and diameter breast height (DBH) was used to determine dominance instead of

coverage. All vegetation sampling was done between 21 June and 28 July 1977.

7. Plant specimens were pressed and dried for identification. These specimens were deposited at the WES herbarium located at the Louisiana Technological University at Ruston, Louisiana. All plant names used in this report are listed in Appendix B by scientific and common names according to Gray's Manual of Botany (Fernald 1950).

Study of Soils

8. Soil samples were taken from the top 10 cm of substrate of the nesting area in order to establish the chemical and physical properties available for plant growth. This sampling was done to document the nutrient levels from the input of bird feces, which was felt to be stimulating to some plant species and toxic to others. No attempt was made at statistical reliability of sampling because only one or two samples were taken at each site. The soil samples were analyzed for the major nutrients; total nitrogen (N), phosphorus (P), and potassium (K), as well as for the pH and texture. Analyses were performed by the Soil Testing Laboratory at Michigan State University, East Lansing, Michigan.

Chronology of Nesting

9. The chronology of the nesting season was determined from field observations by all project personnel and the literature (for great blue herons, Edford 1976; for common terns, Palmer 1941; for black terns, Cuthbert 1954; for herring gulls, Paynter 1949 and Paludan 1951; and for ring-billed gulls, Vermeer 1970; and for herring gulls and Caspian terns, Shugart, unpublished data) to include each event from courtship through fledging. During 1977, an effort was made to determine latitudinal variation in the hatching date of ring-billed gulls by examining developing embryos and measuring tarsi of a sample of newly hatched chicks. Minimum sample sizes of 10 chicks were too small to be statistically significant, but backdating from the growth rates given by Vermeer (1970) established an approximate date of hatching at each site. The eggs of common terns were floated in water to

determine the chronology of the species according to the method of Hays and LeCroy (1971).

PART III: RESULTS

Colonial Nesting Sites of the U. S. Great Lakes

10. During the 2-year study period, 267 bird colonies were located and population estimates obtained. The location, species, and population size of these sites are arranged sequentially from north to south and west to east in Table 1 and in maps in Appendix A. Exceptions to the sequence occur for places where the southward progression of the shoreline is westerly, and where newly located 1977 colony numbers had to be added to the 1976 map sequence. The total number of colonies found (Table 1) increased from 207 in 1976 (Scharf et al. in press) to 267 in 1977 because some colonies were missed the first year, submerged land masses became emergent with the lowered water levels in 1977 and had colonies, and new man-made structures were built or altered and became colony sites. Also contributing to the larger number were the sub-colonies surrounding Isle Royale National Park which are included in Table 1, 1977 column only. Colonies found in 1976 which were abandoned in 1977 are shown on Table 1 in only the 1976 column.

11. Habitats of naturally occuring colony sites showed a range of vegetation succession and vary from bare rock, cobble, gravel, or sand to shrub and tree communities requiring over 50 years to develop. Generalizations are difficult, but common and Caspian terns usually were found in the earliest seral stages, ring-billed and herring gulls in herb-shrub mid-seral stages, black-crowned night herons and cattle egrets in shrub communities, and great blue herons and great egrets in mature trees. Exceptions in the Great Lakes, which were numerous among the gulls and terns, have been discussed in Scharf et al. (in press) and quantified in the specific site vegetation analysis in this report. Also important in characterizing habitat and vegetation succession of colonial nesting sites is the effect of the mechanical and chemical input of the birds on the vegetation as described in this report for specific sites and documented elsewhere by Bongiorno (1970), McColl and Burger (1976) and Wiese (1977).

Table 1

Summary of Sites of Colonial Nesting Birds

Of U.S. Great Lakes, 1976-1977, by Numbers of Nests

Note: DCC = double-crested cormorant, Phalcrocorax auritus
GBH = great blue heron, Ardea herodias
NGH = northern green heron, Butorides striatus
CE = cattle egret, Bubulcus ibis
GE = great egret, Casmerodius albus
SE = snowy egret, Egretta thula
BCNH= black-crowned night heron, Nycticorax nycticorax
HG = herring gull, Larus argentatus
RBG = ring-billed gull, Larus delawarensis
LG = little gull, Larus minutus
FT = Forster's tern, Sterna forsteri
CT = common tern, Sterna hirundo
Cas.T=Caspian tern, Sterna caspia
BT = black tern, Chlidonias niger

*Man-made site

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Superior						(192001-192005 and 191001 have woody vegetation in their interiors.)
Pigeon River Islands 192001	47°57' to 47 59	089°33' to 089 36	226 HG	400 HG	Granite Rock	Mostly Bare
2nd. Island North of Pancake Island 192002	47 53	089 47	22 HG	38 HG	Granite Rock	Mostly Bare
1st. Island North of Pancake Island 192003	47 53	089 49	62 HG	76 HG	Granite Rock	Mostly Bare
Pancake Island 192004	47 53	089 50	44 HG	173 HG	Granite Rock	Mostly Bare
Blueberry Island 192005	47 53	089 50	47 HG	175 HG	Granite Rock	Mostly Bare
Rock West of Marr Island 191016	47 48	090 05	0	12 HG	Granite Rock	Mostly Bare

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Superior (continued)						
Marr Island 191001	47°48'	090°05'	97 HG	264 HG	Granite Rock	Mostly Bare
Guano Island 191002	47 46	090 14	45 HG	69 HG	Granite Rock	Mostly Bare
Rock Island 191003	47 44	090 25	5 HG	27 HG	Granite Rock	Mostly Bare
Gull Island-Taconite Harbor 191004	47 31	090 55	159 HG	189 HG	Granite Rock	Mostly Bare
North Silver Bay 191005	47 17	091 16	324 HG	356 HG	Granite Rock	Mostly Bare
South Breakwater Silver Bay 191006	47 16	091 16	65 HG	72 HG	Granite Rock	Mostly Bare
Beaver Bay Island 191007	47 15	091 17	18 HG	22 HG	Granite Rock	Mostly Bare
1st Island South of Beaver Bay Island 191008	47 13	091 20	45 HG	42 HG	Granite Rock	Mostly Bare
Split Rock Island 191009	47 13	091 22	25 HG	24 HG	Granite Rock	Mostly Bare
Encampment Island 191010	47 05	091 33	130 HG	210 HG	Granite Rock	Tree and Shrub
Knife Island 211001	46 57	091 46	250 HG	280 HG	Granite Rock	Tree and Shrub
Kimble Point 210001	46 43	092 09	47 GBH	55 GBH	Soil	Red Pine

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Superior (continued)						
*Piling Island 210002	46°44'	092°09'	27 HG	200 RBG	Rock and Piling	Tree, Shrub, Bare
*Minnesota Power and Light Company 210003	46 44	092 09	1 HG, 308 RBG, 4 CT	2 HG, 550 RBG	Heavy Soil & Cinder	Herbs & Some Willow
*Port Authority 210004	46 45	092 06	121 CT	5 HG, 234 RBG, 185 CT	Sand	Herbs, Grass & Bare
*Sky Harbor Airport 210005	46 42	092 03	7 CT	6 CT	Sand	Herbs
Roman Point Cliffs 211011	46 50 to 46 55	091 10 to 091 13	10 HG	4 HG	Rock Cliff	Bare
Eagle Island 211002	46 57	091 02	54 GBH, 300 HG	51 GBH, 450 HG	Rock & Soil	Deciduous Trees
Sand Island 211003	46 59	090 57	12 HG	0	Rock Cliff	Bare
Bear Island 191011	47 01	090 45	3 HG	4 HG	Rock Cliff	Bare
Devils Island 191012	47 04	090 44	4 HG	3 HG	Rock Cliff	Bare
Otter Island 191013	47 00	090 42	22 HG	20 HG	Rock Cliff	Bare
Outer Island 191014	47 02	090 26	7 HG	2 HG	Rock Cliff	Bare
Cat Island 191015	47 01	090 34	4 HG	0	Rock Cliff	Bare

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Superior (continued)						
Little Manitou Island 211004	46°58'	090°39'	7 HG	1 HG	Rock Cliff	Bare
Stockton Island 211005	46 56	090 35	6 HG	5 HG	Rock Cliff	Bare
Gull Island 211006	46 53	090 27	273 HG, 99 RBG	291 HG, 67 RBG	Cobble	Shrub & Bare Cobble
Hermit Island 211007	46 53	090 41	17 HG	10 HG	Rock Cliff	Bare
Basswood Island 211008	46 51	090 44	6 HG	8 HG	Rock Cliff	Bare
*Washburn Piling 211009	46 40	090 55	4 HG, 5 CT	0	Rock & Piling	Tree, Shrub, Bare
*Ashland Breakwater 211010	46 37	090 51	8 HG	9 HG, 9 CT	Breakwater	Bare
*Ashland Coal Dock 211012	46 37	090 51	0	8 CT	Dock	Shrub, Herb
Porcupine Mountains Rocks 212001	46 49	089 50	26 HG	12 HG	Rock	Bare
Gull Island 173001	48 16	088 16	88 HG	90 HG	Rock	Bare
Passage Island 173002	48 14	088 20	16 HG	21 HG	Rock	Bare
Isle Royale National Park 173003 Totals:	47 50 to 48 10	089 20 to 088 20	500 HG	18 GBH, 595 HG	Rock	Mostly Bare, Some Tree & Shrub
Rock of Ages Light			not censused	4 HG	Rock	Mostly Bare, Some Tree & Shrub

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Superior (continued)						
Isle Royale National Park (continued)			not censused		Rock	Mostly Bare, Some Trees & Shrub
3rd. Rock South of Washington Island				43 HG		
2nd. Rock South of Washington Island				14 HG		
1st. Rock South of Washington Island				8 HG		
Gull Rocks				16 HG		
4th. Rock North of Wilson Point				10 HG		
North Todd Harbor Rock				36 HG		
2nd. Rock South of Hawk Island				12 HG		
1st. Rock South of Hawk Island				5 HG		
2nd.&3rd. Rock South of Amygdaloid Island				22 HG		
Rock North of Amygdaloid Island				12 HG		
Steamboat Island				34 HG		
South Government Island				5 GBH		
Flag Island				14 HG		
3rd. Rock North of Bat Island				8 HG		
2nd. Rock North of Bat Island				23 HG		

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Superior (continued)						
Isle Royale National Park (continued)			not censused		Rock	Mostly Bare, Some Trees & Shrub
1st. Rock North of Bat Island				3 HG		
2 Rocks South of Shaw Island				5 HG		
1st. Rock South of Mott Island				2 HG		
2nd. Rock South of Mott Island				2 HG		
Middle Passage Island				11 HG		
Tonkin Bay Rock				6 HG		
Rock South of Tonkin Bay Rock				18 HG		
Rock South of Malone Island				14 HG		
Menagerie Island				42 HG		
Long Island				51 HG		
Taylor Reef Rock				8 HG		
Castle Island				66 HG		
1st. Rock South of Long Island				6 HG		
2nd. Rock South of Long Island				2 HG		
Large Rocks North of Pauls' Island				6 HG		

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Superior (continued)						
Isle Royale National Park (continued)			not censused		Rock	Mostly Bare, Some Trees & Shrub
Large Pauls' Island				18 HG		
Small Pauls' Island				13 GBH, 16 HG		
Redfin Island				52 HG		
McCormick Rocks				6 HG		
Rocks south of Eagle Harbor 192006	47°27'	088°12'	27 HG	4 HG	Rock	Bare
Agate Harbor Rocks 192007	47 28	088 04	32 HG	39 HG	Rock	Bare
Copper Harbor Island 192008	47 29	087 53	10 HG	27 HG	Rock	Bare
Manitou Rock 192009	47 25	087 40	32 HG	32 HG	Rock	Bare
Manitou Island 192010	47 25	087 37	10 HG	4 HG	Rock	Bare
* Stamps Sands Island, Lake Linden 192011	47 11	088 25	HG present, but number not known 250 RBG	198 HG, 405 RBG	Stamp Sand	Shrub, Herb, & Bare
* Stamps Sands Island Hubbell 192012	47 10	088 25	5 HG	4 HG	Stamp Sand	Shrub, Herb & Bare
Traverse Island 192013	47 04	088 16	62 GBH, 177 HG	52 GBH, 96 HG	Rock, Soil	Shrub, Tree
Huron Island 213001	46 56	088 00	463 HG	485 HG	Rock	Few trees, mostly Bare Rock

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Superior (continued)						
Larus Island 213002	46°37'	087°26'	160 HG	160 HG	Rock	Bare
Granite Rocks 213003	46 37	087 23	95 HG	102 HG	Rock	Bare
White Rocks 213004	46 36	087 22	106 HG	110 HG	Rock	Bare
Ore Dock Rocks 213005	46 35	087 23	67 HG	72 HG	Rock	Bare, Herb, Shrub
Autrain Island 213006	46 29	086 54	89 HG	96 HG	Rock & Soil	Tree & Shrub
Wood Island 213007	46 30	086 44	50 HG	41 HG	Rock & Soil	Tree & Shrub
Williams Island 213008	46 29	088 43	78 GBH, 500 HG	78 GBH, 320 HG	Rock & Soil	Tree & Shrub
Pictured Rocks 213009	46 29 to 46 32	086 33 to 086 25	206 HG	120 HG	Rock Cliff	Bare
Taquamenon Island 214017	46 35	084 55	400 HG	420 HG	Cobble	Tree, Shrub, Herb
Island South of Taquamenon Island 214018	46 35	084 55	not censused	120 CT	Soil	Herb
Iroquois Island 214016	46 29	084 41	25 HG	28 HG	Cobble	Shrub, Herb
Round Island 214001	46 27	084 31	275 HG, 1454 RBG	300 HG, 1485 RBG	Cobble	Tree,Shrub, Herb

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
St. Marys River						
*Northwest Sugar Island 214002	46°27'	084°16'	81 CT	1 HG, 21 CT	Soil	Herb
*West Sugar Island II 214020	46 26	084 15	OCT, OHG nearly submerged	1 HG, 44 CT	Soil	Herb
*West Sugar Island I 214003	46 26	084 15	139 CT	116 CT	Soil	Herb
Gem Island 214004	46 26	084 11	43 GBH, 27 HG	33 GBH, 29 HG	Soil	Deciduous Tree
Rock Island 214005	46 23	084 09	23 GBH, 53 HG	27 GBH, 48 HG	Soil	Deciduous Tree
*Southeast Neebish Island 214006	46 14	084 07	1 HG, 49 RBG, 136 CT	55 RBG, 45 CT	Loose Rock	Herbs & Bare
*Moon Island 214007	46 13	084 10	18 HG, 982 RBG	7 HG, 1673 RBG	Sand & Muck Dredge	Herb, Shrub, Small Tree
*Southwest Neebish Island 214008	46 13	084 10	1263 RBG	2398 RBG	Muck Dredge	Herb, Some Shrub
Steamboat Island 214009	46 10	084 12	22 HG	16 HG	Soil, Boulder	Bare, Herb
Two Tree Island 214010	46 12	084 05	42 HG	46 HG	Soil, Boulder	Herb, Bare
Round Island 214011	46 06	084 01	39 GBH	39 GBH	Soil	Deciduous Tree
Bass Reef Island 215001	46 06	084 00	47 HG	43 HG	Cobble	Herb
Squaw Island 215002	46 02	083 54	108 HG	91 HG	Boulder, Soil	Herb
West Pipe Island Twin 215003	46 01	083 54	138 HG	145 HG	Cobble	Bare, Herb

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
St. Marys River (Continued)						
East Pipe Island Twin 215004	46°01'	083°54'	79 HG	100 HG	Cobble	Bare, Herb
Harbor Island Reef 215013	46 03	083 47	inundated	2 HG, 192 RBG	Cobble, Boulder	Herb
Propeller Island 215005	46 05	083 45	68 HG	52 HG	Cobble, Soil	Bare, Herb
Arrow Island 215006	46 01	083 49	21 HG	33 HG	Boulder, Soil	Bare, Herb
Bow Island 215007	46 02	083 50	7 HG	0	Cobble, Soil	Tree, Shrub, Herb, Bare
Bacon Island 215008	46 03	083 50	196 HG	192 HG	Boulder, Soil	Bare, Herb
*Macomb Island Dock 215009	46 04	083 52	5 RBG	0	Concrete	None
Andrews Island 215010	46 03	083 53	1815 RBG	0	Soil	Bare, Shrub, Tree, Herb
Little Cass Island 215011	46 04	083 54	7 HG	5 HG, 2063 RBG	Cobble, Boulder	Bare, Shrub
*Watson Reef Ruins 215012	46 00	083 54	53 CT	20 CT	Rock	Bare, Herb
Lake Huron						
*Cable Island 239002	45 59	083 53	23 HG	23 HG	Boulder, Soil	Coniferous Tree
Goetz Shoal 239018	46 04	083 34	inundated	17 HG	Cobble, Boulder	Bare

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Huron (Continued)						
Gravel Island 239002	45°56'	083°46'	4 GBH, 1 HG	3 GBH	Soil	Deciduous Tree, Shrub
Scammon Point 239003	45 56	083 38	34 GBH	40 GBH	Soil	Mixed Coniferous-Deciduous Tree
Point Detour Island Rocks 239004	45 57	083 55	2 HG	0 HG	Boulder	Herb
Carlton Bay Rock 239005	45 58	083 56	1 HG, 25 CT	0 HG, 13 CT	Boulder	None
North Island 239006	45 58	083 58	31 HG	26 HG	Boulder	Herb
South Island 239007	45 57	083 58	98 HG	104 HG	Cobble, Soil	Tree, Shrub
Saddlebag Island 238001	45 57	084 02	32 GBH, 334 HG	15 GBH, 309 HG	Cobble, Soil	Tree, Shrub, Herb
Little Saddlebag Island 238002	45 57	084 03	77 HG	96 HG	Boulder, Soil	Tree, Shrub, Herb
Bear Island 238003	45 58	084 14	87 HG	113 HG	Boulder	Shrub, Herb
Crow Island 238004	45 58	084 14	11 GBH, 241 HG	11 GBH, 196 HG	Boulder, Soil	Tree, Shrub, Herb
Bush Bay Rocks 238005	45 59	084 15	2 HG, 19 CT	1 HG, 8 CT	Boulder	Tree, Herb, Lichen
Goose Island 238006	45 55	084 26	75 GBH, 10 BCNH, 779 HG	67 GBH, 13 BCNH, 561 HG	Cobble, Soil	Coniferous Tree, Shrub Herb
St. Martin Shoals 238007	45 57	084 34	306 HG	439 HG, 66 RBG	Cobble, Boulder	Shrub, Herb

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Huron (continued)						
St. Martin Island 238008	45°58'	084°35'	3 HG, 6 CT	2 HG, 1 RBG, 54 CT	Gravel, Cobble	Bare, Herb
Lake Michigan						
Point LaBarbe Island 238009	45 50	084 46	116 HG	127 HG	Cobble	Tree, Shrub, Herb
Green Island 238010	45 50	084 45	6 BCNH, 589 HG, 1506 RBG	10 BCNH, 644 HG, 2168 RBG	Cobble, Gravel	Tree, Shrub, Herb
St. Helena Island 238011	45 52	084 52	27 GBH	24 GBH	Soil	Mixed Deciduous–Coniferous Tree
Point AuChenes Bay Island 238031	45 55	084 53	0	26 CT	Sand	Herbs, Bare
Brevort River Shoal 238012	45 57	084 56	1 HG, 28 CT	0	Sand	Herb
*Cut River Marina 214018	46 03	085 05	under construction	186 RBG, 95 CT	Riprap	Bare
Epoufette Point Island 214012	46 03	085 12	27 GBH	32 GBH	Soil	Mixed Deciduous–Coniferous Tree
Shoal West of Epoufette Island 214019	46 03	085 13	inundated	27 RBG, 14 CT	Gravel	Bare, Herb
Little Hog Island 214013	46 04	085 17	6 HG	8 HG	Cobble	Herb, Shrub, Bare
1st. Island West of Little Hog Island 214014	46 05	085 18	6 HG	5 HG	Gravel, Cobble	Herb, Shrub, Bare

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Michigan (continued)						
Naubinway Island 214015	46°05'	085°27'	78 HG	88 HG	Gravel, Cobble	Herb, Shrub, Bare
Rocky Island 237032	45 37	086 42	260 HG, 2656-3500RBG	123 HG, 5169 RBG	Soil, Gravel, Cobble	Bare, Shrub, Tree
Summer Island Shoal 237033	45 37	086 42	mostly submerged	9 HG	Gravel, Cobble	Bare
Round Island 237001	45 45	086 46	12 GBH, +21 BCNH, 80-100 HG, 2500-3000 RBG	31 GBH, 26 BCNH, 102 HG, 6905 RBG	Cobble, Gravel	Bare, Shrub, Tree
Snake Island 237002	45 44	086 39	350 HG, +3009 RBG	359 HG, 3550 RBG	Cobble, Gravel/Soil	Herbs
St. Vital Island 237003	45 48	086 45	6 GBH, 2 BCNH, 105 HG, 130 CT	67 HG, 191 CT	Rock, Soil, Sand, Gravel	Willow, Herb
Mouth of Big River 237004	45 50	086 48	4-7 Pair BT	2-4 BT	Marsh	Marsh
Unidentified Island 237005	45 40	086 58	+20 HG, 2 CT	4 HG, 4 CT	Gravel	Bare
Round Island 237006	45 38	087 10	+100 HG	163 HG	Soil, Gravel	Herb, Shrub
Rapid River Marsh 237007	45 55	086 58	+15 BT	10-15 BT	Marsh	Marsh
Kipling Marsh 237008	45 52	087 01	10-17 BT	0	Marsh	Marsh
Kipling South 237034	45 52	087 01	0	3 BT	Marsh	Marsh

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Michigan (continued)						
Cedar River 237009	45°24'	087°21'	1 NGH, +6 BT	1 NGH	Marsh	Shrub
Saunders Point 237010	45 51	087 00	8 BT	0	Land Fill	Bare
*Escanaba Tank Farm 237011	45 46	087 04	+3 BT	0	Marsh	Marsh
Portage Point 237012	45 42	087 05	3 NGH, 2 LG, 85 CT, +43 BT	2 NGH, 1 LG, 34 CT, 56 BT	Marsh, Soil	Herb
Ford River 237013	45 40	087 09	12-15 BT	0	Marsh	Marsh
Sea Gull Bar 237014	45 05	087 35	10-17 BT	3-5 BT	Marsh	Marsh
Peshtigo Point 261001	44 59	087 39	7-10 NGH, 16 HG, 35-40 FT, 10 CT,60-70BT	3-5 NGH, 12 HG, 5 CT, 10-12 BT	Sand	Bare, Debris
Oconto Marsh 261002	44 54	087 51	100 NGH, 13 CE, 2 SE, 275-350 BCNH, 75 FT, 35-45 BT	20 NGH, 14 CE, 300 BCNH deserted, 10-15 BCNH,2 FT,13 BT	Marsh	Dead Shrub, Cattail
Oconto South Shore 261013	44 53	087 52	0	8-9 BT	Marsh	Marsh
Charles Pond Wildlife Area 261003	44 46	087 57	6 BT	0	Marsh	Marsh
Little Suamico Swamp 261004	44 42	088 00	7-9 GBH, 12-18 BT	15 GBH	Willow	Tree
Little Tail Point 261005	44 40	087 59	7-10 NGH, 103 FT	5 NGH	Marsh	Marsh

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Michigan (continued)						
Sensiba Wildlife Area 260001	44°38'	088°01'	28 BT	4 NGH, 6FT (Deserted) 15 BT	Marsh	Marsh
Long Tail Point 261006	44 36	087 59	35-40 BCNH, 7 HG, 3 RBG	1 NGH, 15 BCNH (Deserted)	Sand	Shrub
Peter's Marsh 260002	44 35	088 01	7-12 BT	2-3 BT	Marsh	Marsh
Cat Island Chain 260003	44 34	088 00	19 DCC	14 DCC(Destroyed)	Submerged	Tree
*Bay Port Industrial Tract 250004	44 33	088 01	80 FT, 75-80 BT	45-52 FT, 26-31 BT	Marsh	Marsh
Point Au Sauble 261007	44 35	087 54	3 NGH, 6-9 BT	3 NGH, 10 BT	Marsh	Marsh
* Willow Island 261008	44 34	088 00	46 BCNH, 9 HG	224 BCNH, 10-15 CE, 16 HG	Sand, Dredge	Willow, Shrub
Cat Island 261014	44 34	088 00	0	70 BCNH, 8 HG	Sand	Bare, Herb, Shrub
* Lone Tree Island 261009	44 34	088 00	3 HG, 213 RBG, 91 CT	2 HG, 374 RBG, 108 CT	Rubble, Soil	Bare, Herb, Shrub, Tree
Green Island 237015	45 03	087 30	394 HG	70-90 BCNH, 509 HG	Sand-gravel, Soil	Bare, Herb, Coniferous Tree
Hat Island 237016	45 06	087 19	32-40 BCNH, 800-1000 HG, 50-60 RBG	79 BCNH, 900-1100 HG, 219 RBG	Soil, Cobble	Herb, Shrub
Jack Island 237017	45 10	087 16	800 HG	12-20 BCNH, 850 HG	Soil, Cobble	Herb, Shrub

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Michigan (continued)						
Middle Strawberry Island 237018	45°10'	087°16'	20–30 HG	20–30 HG	Gravel	Bare, Shrub
Little Sister Island 237019	45 12	087 10	102 HG	121 HG	Gravel	Bare
Big Sister Island 237020	45 12	087 10	471 HG	531 HG	Cobble, Soil	Herb
Hog Island 237021	45 22	086 46	75–125 HG	118 HG	Rock, Soil	Herb, Shrub, Tree
Pilot Island 237022	45 17	086 55	35 HG	72 HG	Rock, Soil	Herb, Shrub, Tree
Fish Island 237023	45 24	086 46	18 DCC, 105 HG	52 DCC	Cobble	Bare
Gull Island 237024	45 30	086 43	505 HG	533 HG	Rock, Soil	Herb, Shrub, Tree
Little Gull Island 237025	45 30	086 43	+8 BCNH, 400 HG	5 BCNH, 536 HG, 22 Cas. T	Rock, Soil	Herb, Shrub, Tree
Gravelly Island 237026	45 31	086 43	11 DCC, 313 HG, 550–600 Cas. T	9 DCC, 408 HG, 537 Cas. T	Cobble	Bare, Herb
Poverty Island 237035	45 32	086 40	0	8 BCNH	Tree	Coniferous Tree
Spider Island 237027	45 13	086 59	6 BCNH, 450–550 HG	11 BCNH, 857 HG	Rock, Gravel, Soil	Bare, Herb
Gravel Island 237028	45 15	086 58	250 HG	391 HG	Rock, Sand	Grass, Bare

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Michigan (continued)						
Kangaroo Lake 237029	45°03'	087°10'	15–20 BT	5–7 BT	Marsh	Marsh
Kewanee Marsh 261010	44 28	087 31	50–60 BT	0	Marsh	Marsh
* Kewanee Engineer Corporation 261015	44 28	087 30	not censused	247 HG, 1292 RBG	Soil	Grass, Herb, Bare
* Kewanee Harbor 261011	44 28	087 30	9 HG	11 HG	Concrete	Bare
Two Rivers 261012	44 10	087 35	1 HG, 2 RBG, 60 BT	3–5 BT	Marsh	Marsh
Mink River 237030	45 15	087 03	5–8 BT	2–3 BT	Marsh	Marsh
South Manitou Island 237031	45 03	086 05	428 HG, 4060 RBG	470 HG, 2686 RBG	Sand	Grass, Herb
Bellows Island 238013	45 06	085 34	728 HG	705 HG	Sand, Gravel, Cobble	Grass, Herb, Shrub, Tree
Gull Island 238014	45 42	085 50	1426 HG	1750 HG, 254 RBG	Sand, Gravel, Cobble	Grass, Herb, Shrub
High Island 238015	45 45	085 40	4 HG, 3313 RBG, 411 Cas. T, 63 CT	7 HG, 3442 RBG, 87 CT, 30 Cas. T (plus 86 Cas. T renests, not in total)	Sand, Gravel	Bare, Herb, Shrub
High Island Shoal 238031	45 45	085 40	inundated	42 Cas. T (renests not in total)	Sand, Gravel	Bare
Trout Island 238016	45 47	085 42	134 HG	105 HG	Gravel	Herb, Shrub, Tree

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Michigan (continued)						
Whiskey Island 238017	45°49'	085°37'	13 HG	13 HG	Gravel	Herb, Shrub
Squaw Island 238018	45 51	085 36	50 HG	72 HG	Sand	Herb, Shrub
Pismire Island 238019	45 46	085 27	270 HG	238 HG	Gravel	Cobble
Pismire Reef 238033	45 50	085 30	mostly submerged	2 HG, 80 CT	Cobble	Bare
East Grape Island 238020	45 47	085 24	1 HG, 1188 RBG	4 HG, 1278 RBG, 11 CT	Cobble, Soil	Bare, Tree, Shrub, Herb
West Grape Island 238021	45 47	085 25	5 GBH, 4 HG, 3979 RBG	3 GBH, 6 HG, 3660 RBG	Cobble, Soil	Bare, Tree, Shrub, Herb
Hat Island 238022	45 47	085 18	3 GBH, 690 HG, 730 Cas. T	603 HG, 686 Cas. T	Gravel, Cobble	Bare, Tree, Shrub, Herb
Shoe Island 238032	45 48	085 18	inundated	6 HG, 53 Cas. T (Renests not in total)	Gravel, Cobble	Bare
Ile aux Galets 238023	45 41	085 11	121 HG, 4000 RBG, 316 Cas. T	131 HG, 2870 RBG, 312 Cas. T	Gravel, Soil, Cobble Boulder	Herb, Shrub, Tree
Waugoshance Island 238024	45 46	085 04	18 GBH	33 GBH	Soil	Deciuous Tree
Waugoshance Point 238025	45 46	085 00	20 CT	0	Sand	Herb, Bare

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Michigan (continued)						
Waugoshance Point 238026	45°46'	085°01'	100 CT	11 RBG, 18 CT	Sand	Herb, Shrub, Bare
Big Stone Bay Island 238027	45 45	084 53	2 HG	25 HG	Cobble, Sand	Herb, Bare
*Cecil Bay Breakwater 238028	45 46	084 47	50 RBG, 100 CT	50 RBG, 80 CT	Concrete, Stone	Bare
Lake Huron						
Packard Point Island 238029	45 43	084 26	187 HG	5 HG	Cobble	Shrub, Bare
Duncan Bay Shoal 238030	45 40	084 26	35 CT	Connected to mainland.	Sand	Herb, Bare
* Calcite Plant 239008	45 25	083 46	838 HG, 5593 RBG	873 HG, 7916 RBG	Sand, Gravel, Soil	Herb, Bare
Middle Island 239019	45 11	083 20	0	9 HG	Cobble, Gravel	Bare, Shrub
Island south of 9 Mile Point 239020	45 08	083 21	0	2 HG	Cobble	Bare
Misery Bay Shoal 239009	45 05	083 18	35 HG, 125 CT	12 HG, 70 RBG	Sand	Bare, Herb
South Round Island 239010	45 05	083 18	6 HG	4 HG	Sand	Bare, Herb
Gull Island 239011	45 03	083 14	33 GBH, 27 BCNH, 1510 HG	33 GBH, 29 BCNH, 1220 HG	Sand, Cobble	Bare, Herb, Shrub, Tree

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Huron (continued)						
Sugar Island 239012	45°03'	083°13'	275 HG	288 HG	Sand, Rock	Bare, Tree, Shrub
Thunder Bay Island 239013	45 02	083 12	525 HG, 2697 RBG, 200 CT	475 HG, 2856 RBG, 138 CT	Rock	Bare, Grass, Herb
Whitefish Bay Shoal 239014	45 04	083 22	15 CT	0	Sand	Herb, Bare
*Huron Portland Cement Company 239015	45 04	083 25	2238 RBG	1504 RBG	Soil Fill	Herb, Bare
*Abitibi Waste Island 239018	45 04	083 27	Colony not present.	12 CT	Dredged Dike	Bare
Grassy Island 239016	45 02	083 26	16 BCNH, 150 HG	18 BCNH, 150 HG	Soil	Shrub, Tree
*Bare Point Harbor 239017	45 02	083 27	60 CT	50 CT	Rubble	Herb, Bare
Sulfur Island 263001	45 00	083 25	250 HG, 1655 RBG	250 HG, 1143 RBG	Sand, Soil	Herb, Shrub, Tree
Scarecrow Island 263002	44 55	083 20	24 GBH, 900 HG	18 GBH, 988 HG	Sand, Gravel	Herb, Shrub, Tree
Bird Island 263003	44 53	083 20	88 HG, 2275 RBG	120 HG, 2460 RBG	Sand, Gravel	Herb, Shrub, Bare
Black River Island 253004	44 50	083 18	1064 HG	1200 HG	Gravel, Cobble	Herb, Bare
Little Charity Island 263005	44 00	083 28	BCNH (present, but not censused) 455 HG	86 BCNH, 978 HG	Gravel, Cobble, Soil	Herb, Shrub, Tree

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Huron (continued)						
Nayaquining Point 291001	43°46'	083°57'	6 BCNH	0	Marsh	Marsh, Willow
*Channel Island 291002	43 40	083 49	4 BCNH, 2021 RBG	16 BCNH, 1666 RBG, 64 CT	Sand, Muck	Herb, Willow
*Shelter Island 291003	43 40	083 50	1 BCNH, 2087 RBG	5 HG, 1723 RBG	Sand, Muck	Herb, Willow
Windy Point-Weadock 291004	43 39	083 50	3 BCNH	4 BCNH	Sand	Willow
*Sebewaing Breakwater 291005	43 45	083 29	98 RBG, 287 CT	0	Muck	Herb
Lone Tree Island 291006	43 48	083 29	10 RBG, 25 CT	4 HG, 25 CT	Sand	Bare
Katchay Island Marsh 291007	43 50	083 26	50 RBG	0	Sand	Herb
Lake St. Clair						
Dickinson Island 318001	42 37	082 38	57 GBH, 2 GE	37 GBH, 1 GE	Soil	Deciduous Tree
Detroit River						
*Mud Island 318002	42 14	083 08	5040 RBG	2 HG, 5290 RBG	Muck, Riprap	Herb, Shrub, Tree
*Grassy Island 318004	42 15	083 07	0	1644 RBG, 20 CT	Pumped Dredge	Bare, Herb, Shrub
Stoney Island 318003	42 06	083 08	14 GBH, 29 GE	11 GBH, 23 GE	Soil	Deciduous Tree

(Continued)

Table 1 (Continued)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Erie						
*Toledo Harbor Dike 346001	41°42'	083°26'	6 HG, 77 CT	13 HG, 59 RBG, 263 CT	Pumped Dike, Dredge Material	Herb, Bare
West Sister Island 346002	41 44	083 07	1600 GBH, 200 GE, 3000 BCNH, 150 HG (Corrected)	1600 GBH, 200 GE, 3000 BCNH, 150 HG	Soil, Rock	Shrub, Tree, Bare
Rattlesnake Island 346003	41 41	082 51	72 HG	56 HG	Rock, Cliff	Bare
Green Island 346004	41 39	082 52	6 HG	33 HG	Rock	Bare
Starve Island 346005	41 37	082 49	130 HG	78 HG	Rock	Bare
Winous Point 346006	41 28	082 55	1634 GBH	938 GBH	Soil	Deciduous Tree
*Sandusky Turn Point 346007	41 27	082 43	983 HG	878 HG	Soil, Riprap	Herb, Shrub, Bare
Niagara River						
*Buffalo Breakwater 320001	42 53	078 54	46 CT. HG's and RBG's present but not censused.	50 HG, 524 RBG, 121 CT	Concrete, Cobble, Sand	Bare
*Southeast Buckhorn Island 292001	43 04	079 00	2638-3640 RBG, 46 CT	3704 RBG, 41 CT	Soil, Riprap	Herb
International Control Structure292003 (grassy island)	43 08	079 04	Not censused	4 HG, 1105 RBG, 356 CT	Rock	Bare
Niagara Gorge 292002	43 12	079 03	40 HG	56 HG	Cliff, Rock	Bare

(Continued)

Table 1 (Concluded)

SITE	LATITUDE	LONGITUDE	1976	1977	SUBSTRATE	VEGETATION
Lake Ontario						
Sandy Pond Island 293003	43°35'	076°11'	0	11 NGH, 5 CT	Sand	Bare, Herb, Shrub, Tree
Little Galloo Island 293001	43 53	076 24	+76 DCC, 121 BCNH, 200 HG, +30,000 RBG	96 DCC, 2 CE, 130 BCNH, 200 HG, 27,308 RBG	Soil	Herb, Shrub, Tree
Gull Island 293002	43 51	076 13	10 HG	6 HG	Cobble	Bare, Shrub, Tree
Bass Island 293004	43 55	076 10	0	7 HG, 37 RBG	Cobble, Sand	Bare, Herb, Shrub, Tree

Note: A small ring-billed gull colony is known from an island in Lake Calumet (American Birds, 1976, 30:963). A heronry in the same vicinity is also noted, but both sites are outside the limits of this study.

In all cases of variance, the numbers in this table take precedence over the 1976 interim report (Scharf et al. in press).

12. Thirty-two of the nesting sites in Table 1 are either man-made or man-influenced structures where the development of succession patterns of vegetation and ages of island were analyzed according to the method of Soots and Parnell (1975) for dredged material islands in North Carolina. Little correlation between age of the islands and succession of vegetation was evident because of variations in plant succession and parent dredged materials. Rock, sterile sands, and gravels were dredged in some Great Lakes areas, and heavy mucks and clays in others. These variations combined with ice conditions comprised a varied list of factors other than age that influenced habitat development. Present dredging policy in the Great Lakes prohibits open-water disposal. Thus all of the recent (10 years) dredged material deposits were at confined sites that prevent contamination of the surrounding water. This practice of diking formed a distinctive type of dredged material structure that should be considered separately from open water sites. Older open-water dredged material islands with bird colonies ranged in age from 11 to 77 years since completion of dredging, but some of the oldest of these showed significantly retarded succession rates due primarily to parent material, effects of bird usage, and erosion or inundation due to lake levels.

Study of Selected Bird Colonies

13. The following are descriptions of the breeding populations, vegetation analysis, and noteworthy information on vegetation-bird interactions at eight natural and 16 dredged material sites selected for comparison. Each site description is accompanied by an aerial photograph overlaid with a map showing sampling, transect, locations, and colony borders. (Figures 1-23b).

Site 1. Duluth Port Authority

14. Location: 46°45' N., 092°06' W., a mainland man-made site along the harbor of Duluth, Minnesota (Figure 1).

Species and Number of Nests:

common terns:	1976-121
	1977-185
ring-billed gulls:	1977-234
herring gulls:	1977-5
Colony Size:	1976 - 13.77 ha
	1977 - 1.5 ha common terns
	1.0 ha ring-billed gulls

History: This area has had a long history of common tern nesting (Scharf 1971a). In May and June 1976, bare sand was exposed by bulldozing and excavation over the entire site (Figure 1). The area began to revegetate during late 1976 and 1977.

Nesting Success: Common terns were successful in fledging chicks in 1976 although the onset of laying was retarded by excavation, and the resultant late laying produced widely spaced nests (10 to 20 m) as described for bare areas by Palmer (1941). In 1977 the density of common tern nests was greater and the nesting chronology was more similar to that found in other Great Lakes colonies of this species. Fledging success appeared to be good, but heavy vehicle traffic on the border roads and human intrusions into the colony accounted for some excess mortality. The ring-billed gull colony had nests which were widely spaced and had several stages present at the same time which was found to be typical of first-year, small colonies. Less than optimal nesting success is hypothesized because of the apparent asynchrony and dispersion of nests in this species. No information was obtained on the success of herring gull nests at this site.

15. Habitat: The 1976 excavation work at this site offered an excellent opportunity to study succession of vegetation and its relationship to common terns and ring-billed gulls. Importance values of the plant species (Table 2) showed similarities between the common tern

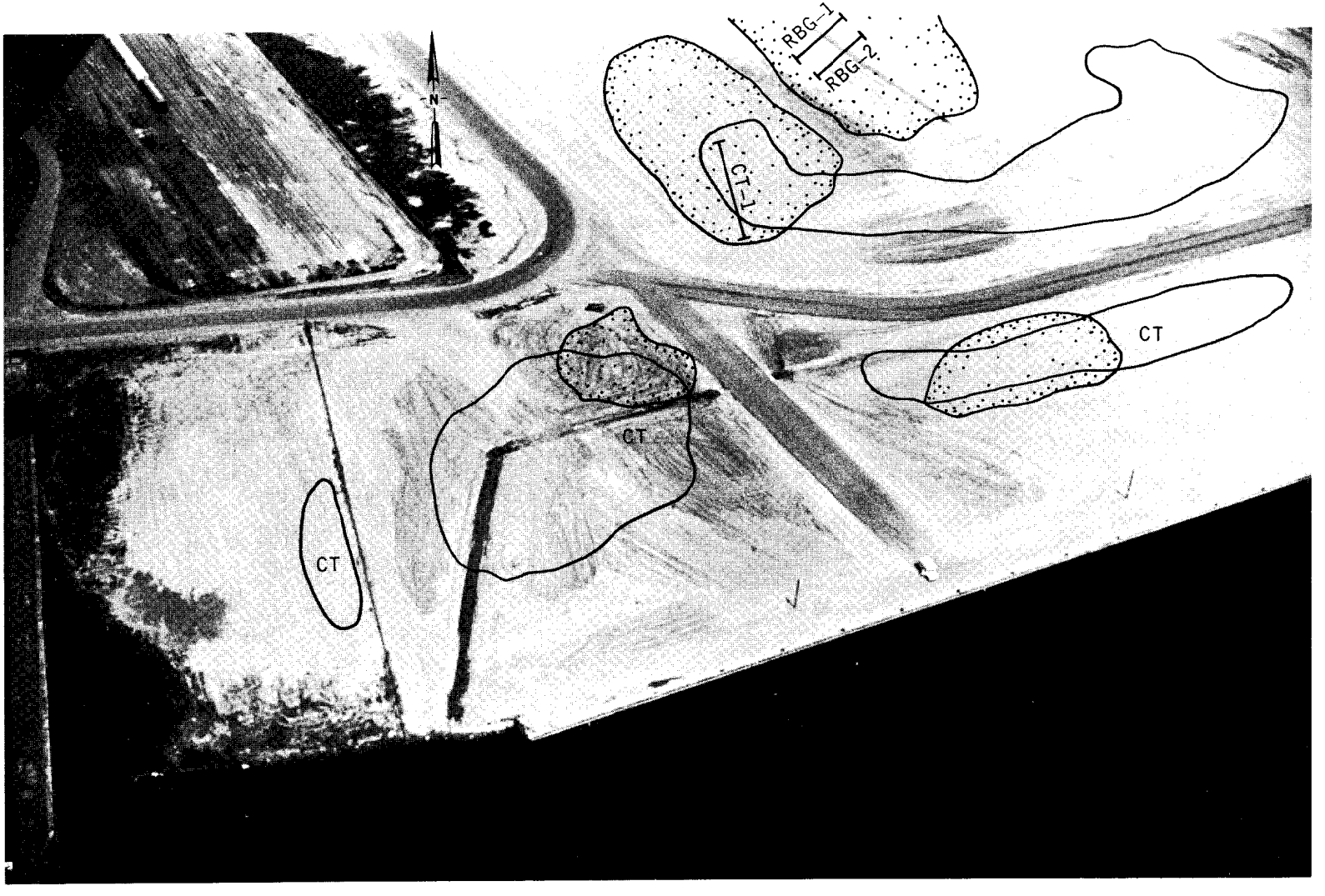


Figure 1. Duluth Port Authority showing a ring-billed gull colony and vegetation sampling transects

Table 2

Duluth Port Authority

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	CT[1]	RBG-1[2]	RBG-2
1 m^2 Quadrats*	(20)	(10)	(10)
Witch-grass (*Agropyron repens*)	-	9	5
Burdock (*Arctium* sp.)	13	55	82
Wormwood (*Artemesia caudacta*)	50	20	-
Common winter-cress (*Barbarea vulgaris*)	-	16	7
Pigweed (*Chenopodium album*)	10	9	21
Squirrel-tail grass (*Hordeum jubatum*)	5	-	-
Lettuce (*Lactuca canadensis*)	-	4	4
White melilot (*Melilotus alba*)	116	105	94
Evening primrose (*Oenothera biennis*)	8	-	10
Smartweed (*Polygonum lapathifolium*)	60	70	74
Sandbar-willow (*Salix interior*)	-	4	-
Tumble-mustard (*Sisymbrium altissimum*)	37	4	5
Yellow clover (*Trifolium agrarium*)	-	6	-

*Sample sizes are indicated in parenthesis.

1. CT= common tern.

2. RBG= ring-billed gull.

and ring-billed gull vegetation associations with tall (0.75 to 1 m) white meliot (Melilotus alba) being most important and a variety of lower herbs and grasses forming an understory vegetation. Two differences noted were the greater importance of burdock (Arctium sp.) in the ring-billed gull colony and greater importance of tumble-mustard (Sisymbrium altissimum) in the common tern colony. If the bird usage remains similar, these apparently minor differences may be precursors to an increase in importance of burdock in the ring-billed gull area. Percent coverage values (Tables 26 and 27) showed that the ring-billed gull colony had 34-47 percent more coverage than the common tern colony. This result was not expected because several bare openings were found within the ring-billed gull colony showing the puddling effect created by the action of feces and trampling by this species (Scharf et al. in press).

Site 2. Minnesota Power and Light Company

16. Location: 46°44' N., 092°09' W., a mainland man-made site along the harbor of Duluth, Minnesota (Figure 2).

Species and Number of Nests:

ring-billed gulls:	1976-308
	1977-550
herring gulls:	1976-1
	1977-2
Colony Size:	0.29 ha.

History: The first year of gull nesting at this site, 1973, coincided with the switch to oil as fuel by the adjacent generating plant, freeing this peninsula which had served as a coal dock.

Nesting Success: The strewn railroad ties from a former track afforded valuable visual and physical isolation between nesting territories and allowed relatively high nesting success at this site.

17. Habitat: The importance values for this site (Table 3) show a predominantly herbaceous cover for the first two transects near the base of the peninsula with progressively more sandbar willow (Salix interior) shrub cover toward the end at transects 3 and 4 (Figure 2).

Table 3

Minnesota Power and Light Company

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	RBG-1[1]	RBG-2	RBG-3	RBG-4
1 m^2 Quadrats*	(8)	(8)	(6)	(5)
Common yarrow (Achillea millefolium)	13	-	-	-
Witch-grass	148	165	106	142
ragweed (Ambrosia sp.)	15	28	-	-
Wormwood	13	44	-	-
Common milkweed (Asclepias syriaca)	-	10	25	16
Canada thistle (Cirsium arvense)	-	10	-	-
Pineapple-weed (Matricaria matricarioides)	5	10	-	-
June grass (Poa pratensis)	29	18	-	-
Raspberry (Rubus idaeus var. strigosus)	15	-	-	27
Sandbar willow	-	-	91	59
Tumble-mustard	6	16	-	-
Goldenrod (Solidago sp.)	26	-	-	-
Common tansy (Tanacetum vulgare)	28	-	76	59

*Sample sizes are indicated in parenthesis.

+ = Trace.

1. RBG = ring-billed gull.

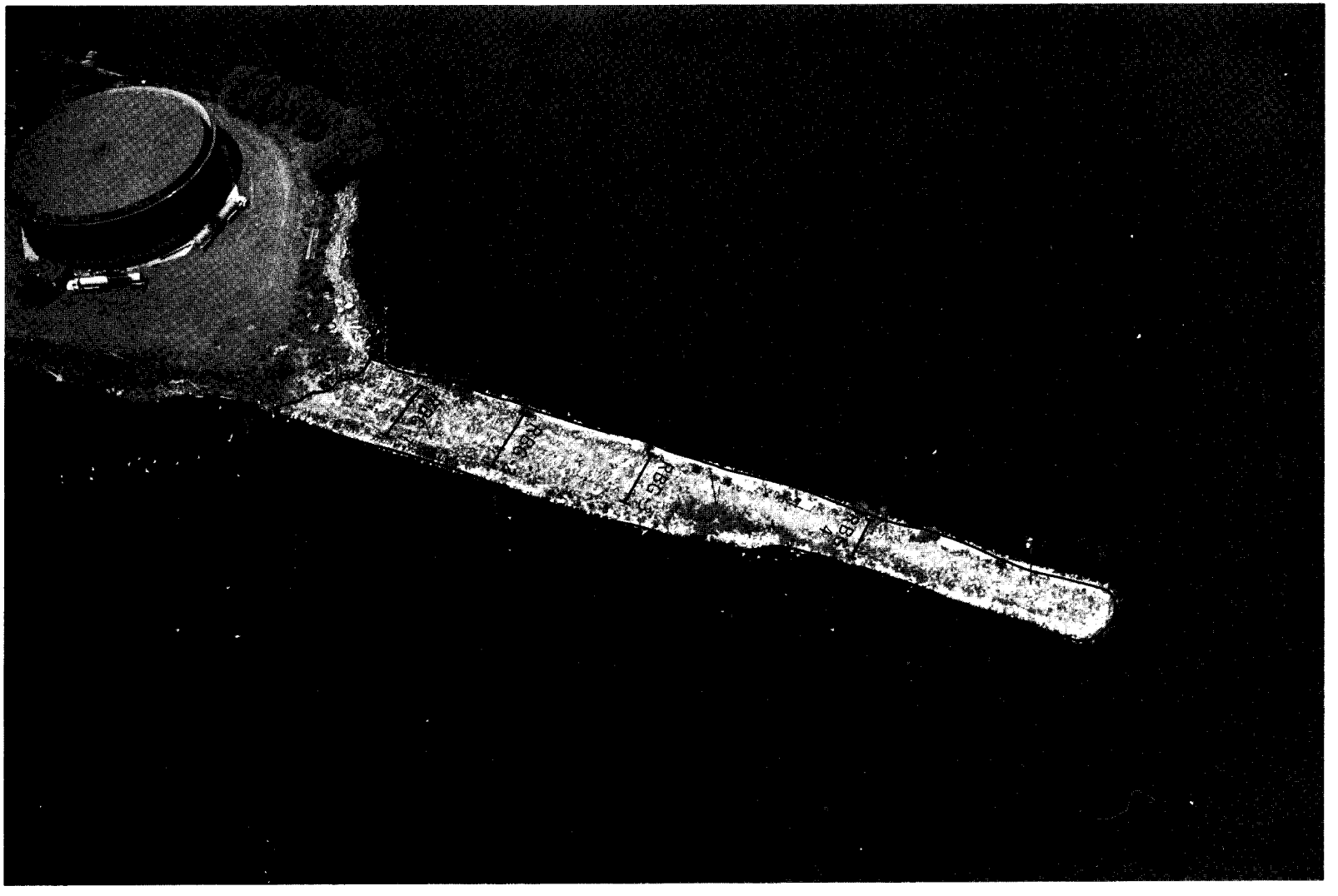


Figure 2. Minnesota Power and Light Company showing nesting of ring-billed gulls and vegetation sampling transects

No differences in the gull nesting density were noted because of this change. It was evident that witch-grass (Agropyron repens) gained an exaggerated importance value because of its high numbers in the dense sod. Average percent vegetation coverage for this site (33 percent) was more typical than the previous site for ring-billed gulls with continuous occupancy reflecting a large amount of puddled vegetation and bare area.

Sites 3, 4, and 5. Northwest Sugar Island, West Sugar Island II, and West Sugar Island I.

18. Locations: 46°27' to 46°26' N., 084°16' to 084°15' W., small dredged material islands in the St. Mary's River, 6 to 9 km southeast of Sault St. Marie, Michigan (Figures 3, 4, and 5).

Species and Number of Nests:

Northwest Sugar Island	common terns:	1976-81
		1977-21
	herring gulls:	1977-1
West Sugar Island II	common terns:	1977-44
	herring gulls:	1977-1
West Sugar Island I	common terns:	1976-139
		1977-116

Colony Size: 0.05 to 0.17 ha

History: These dredged material islands were formed atop natural islands between 1900 and 1960. In recent high water years they eroded extensively. Comparison of Figures 3 and 5 taken in 1976 with Figure 4 taken in 1977 showed that the lower lake levels of 1977 nearly tripled the emergent portions of these islands.

Nesting Success: Each of these sites was rated as highly successful. Although only 3790 of the eggs in the three colonies hatched, nearly 90 percent of the chicks fledged (Appendix D).

19. Habitat: The vegetation importance values (Tables 4, 5, and 6) show a wide mixture of herbaceous species with indications of invasion of shrubby plants such as sandbar willow and balsam poplar (Populus balsamifera). The increase in surface due to lowered water

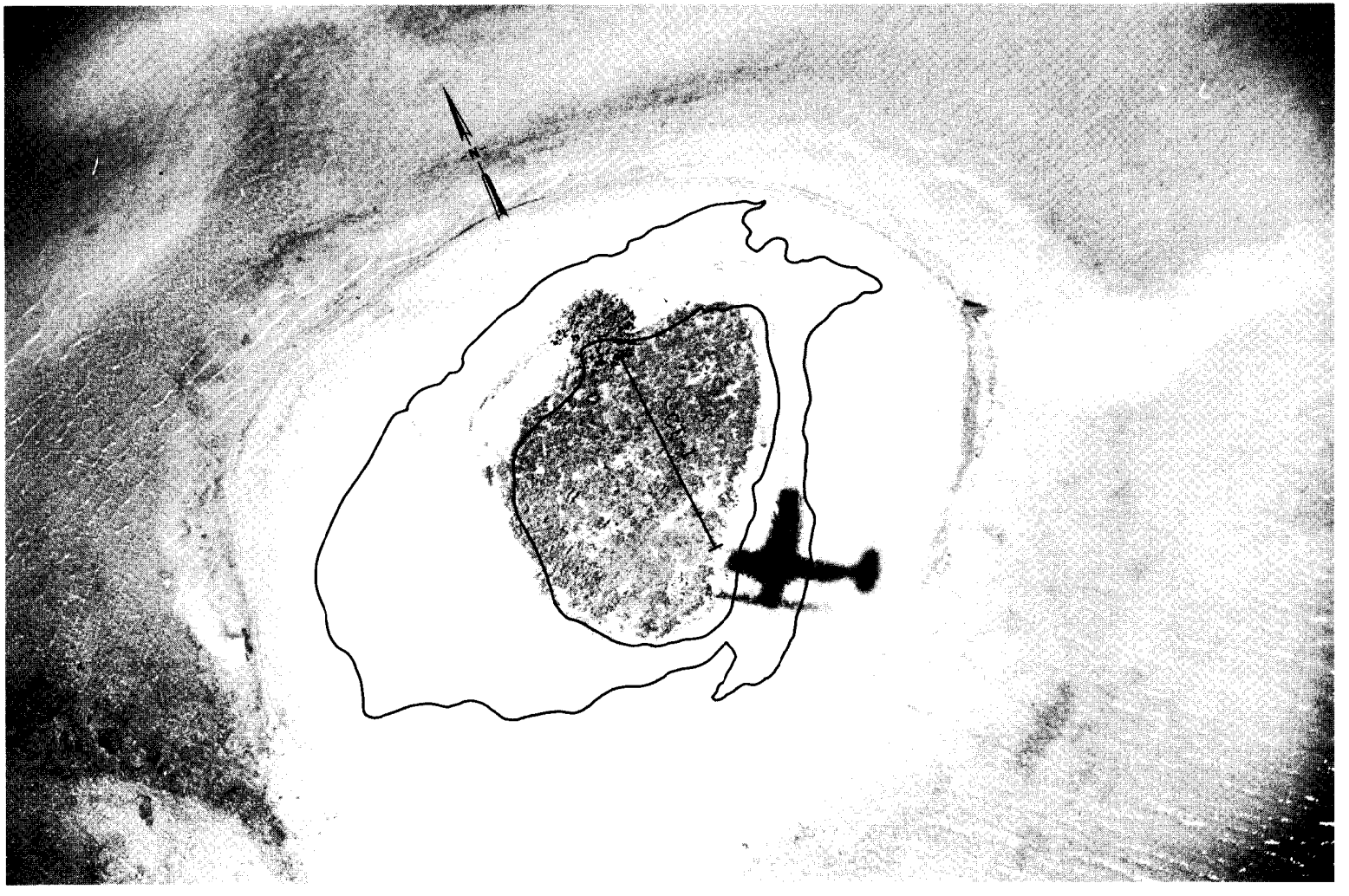


Figure 3. Northwest Sugar Island showing a common tern colony and a vegetation sampling transect

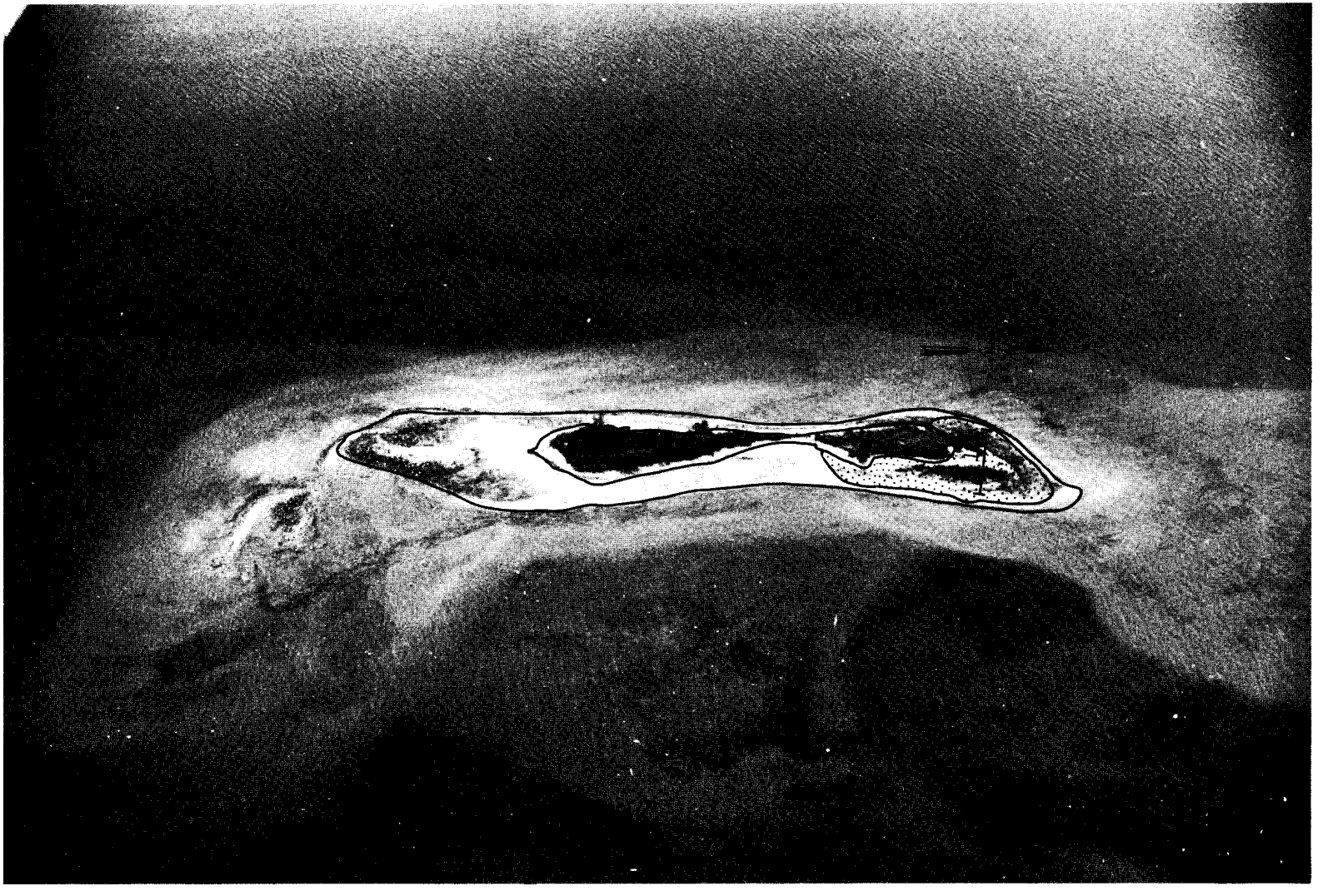


Figure 4. West Sugar Island II showing a common tern colony and a vegetation sampling transect

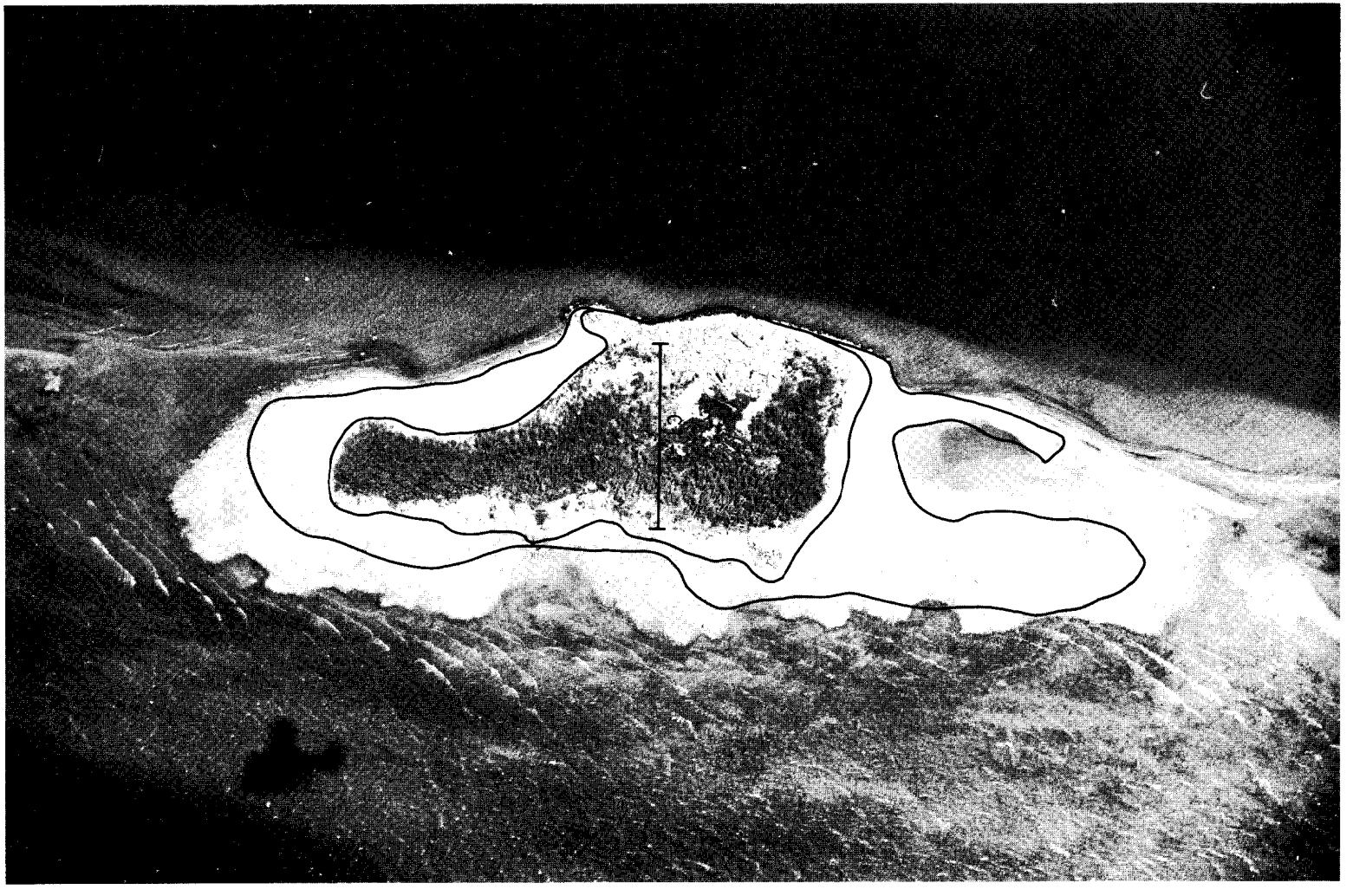


Figure 5. West Sugar Island I showing a common tern colony and a vegetation sampling transect

Table 4

Northwest Sugar Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	COMMON TERN
1 m^2 Quadrats*	(14)
Common yarrow	7.9
Common winter-cress	10.2
Sedge (*Carex* sp.)	1.2
Pigweed	4.7
Field daisy (*Chrysanthemum leucanthemum*)	6.7
Canada thistle	10.5
Great willow-herb (*Epilobium augustifolium*)	1.2
Horsetail	40.6
Orange hawkweed (*Hieracium aurantiacum*)	4.0
White melilot	8.7
Moss (Unidentified)	3.7
Common timothy (*Phleum pratense*)	4.0
Common plantain (*Plantago major*)	5.2
June grass	91.9
Smartweed	46.6
Tumble-mustard	9.3
Goldenrod	21.6
Field-sowthistle (*Sonchus arvensis*)	14.2
Common dandelion (*Taraxacum officinale*)	2.3
Yellow clover	1.4
Red clover (*Trifolium pratense*)	9.8

*Sample sizes are indicated in parenthesis.

Table 5

West Sugar Island II

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	COMMON TERN
1 m^2 Quadrats*	(15)
Common winter-cress	7.2
Sedge	14.7
Pigweed	20.0
Canada thistle	2.1
Rush (*Juncus* sp.)	18.4
White melilot	22.2
Common plantain	2.4
June grass	32.7
Smartweed	148.6
Tumble-mustard	13.9
Common dandelion	1.9
Yellow clover	1.9
Red clover	9.8

*Sample sizes are indicated in parenthesis.

Table 6

West Sugar Island I

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	COMMON TERN
1 m^2 Quadrats*	(12)
Sugar maple (*Acer saccharum*)	4.2
Common winter-cress	4.7
Sedge	5.8
Pigweed	19.2
Spotted touch-me-not (*Impatiens capensis*)	26.8
June grass	35.0
Smartweed	17.7
Balsam poplar (*Populus balsamifera*)	12.4
Sandbar willow	150.4
Bittersweet (*Solanum dulcamara*)	4.9
Field-sowthistle	14.3
Common dandelion	4.5

*Sample sizes are indicated in parenthesis.

levels led to a partial shift (56.3 percent of the nests) of the common terns from the vegetated areas where they nested in 1976 to the bare sands and clays exposed in 1977. West Sugar Island II was not used for nesting in 1976, but appeared to have been colonized in response to newly exposed bare areas that were available for nesting as the water receded.

Sites 6 and 7. Moon Island and Southwest Neebish Island

20. Locations: 46°13' N., 084°10' W., two dredged material islands in the St. Marys River, 14.5 km northeast of Pickford, Michigan (Figures 6 and 7).

Species and Number of Nests:

Moon Island:	herring gulls:	1976-18	
		1977-7	
	ring-billed gulls:	1976-982	
		1977-1673	
Southwest Neebish Island/ring-billed gulls:		1976-1263	
		1977-2398	

Colony Size:

Moon Island:	herring gulls:	1976-1977	0.61 ha
	ring-billed gulls:	1976-0.32	ha
		1977-0.55	ha
Southwest Neebish Island:		1976-0.34	ha
		1977-0.61	ha

History: The islands were the result of dredged material deposited over natural islands from 1900 to 1957. The herring gulls were noted present by Ludwig (1962) and ring-billed gulls were reported at this site by Scharf (1971a).

Nesting Success: No unusual mortality factors were apparent, and it was believed that chick survival was excellent. Hatching was retarded (10 percent and 21 percent) in newly exposed land areas compared to pre-existing areas of the same islands (83 percent and 84 percent).

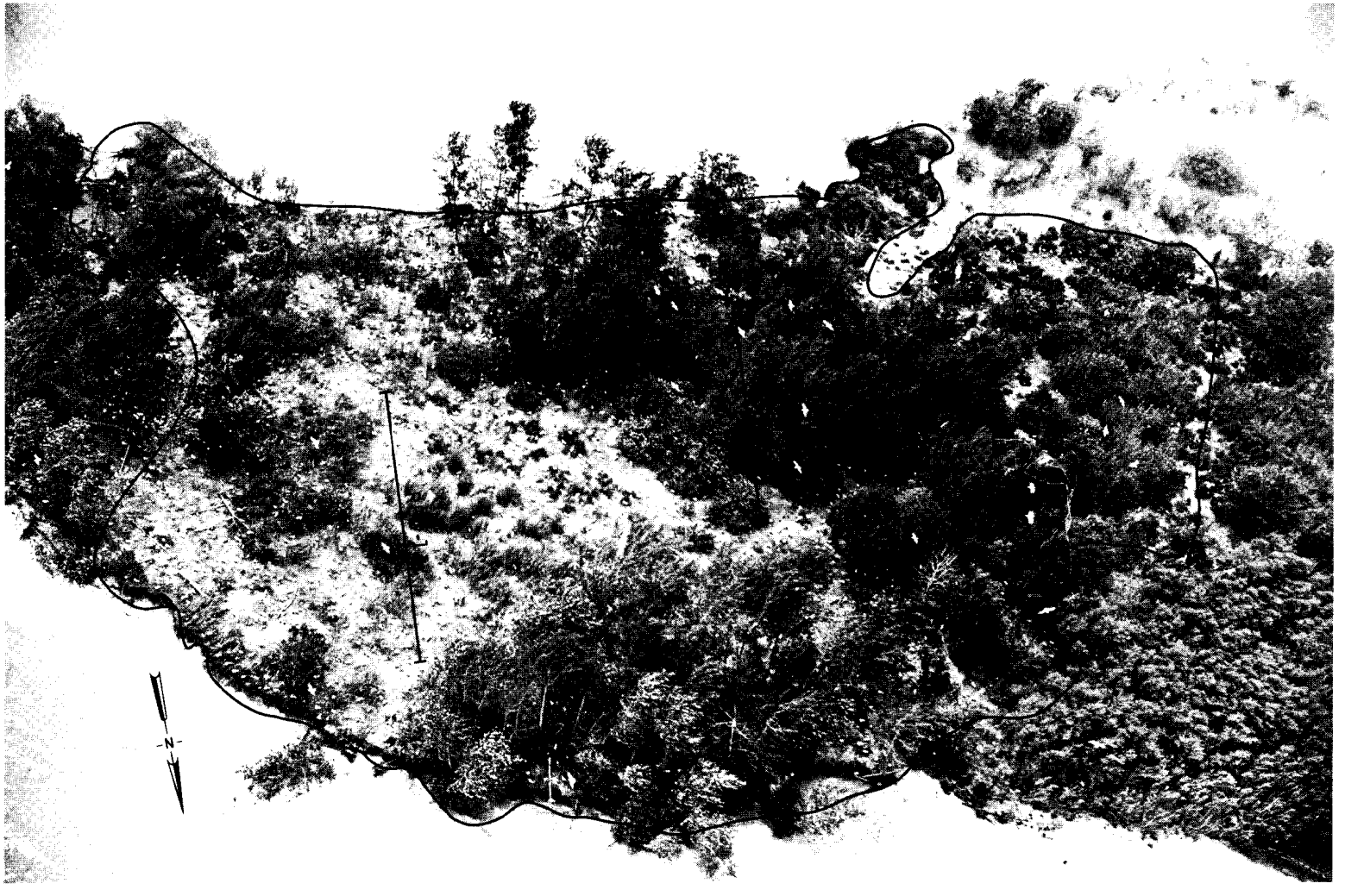


Figure 6. Moon Island showing a ring-billed gull colony and vegetation sampling transects

Figure 7. Southwest Neebish Island (in part) showing a ring-billed gull colony and vegetation sampling transect

21. Habitats: These locations were very similar in that heavy clay substrates were mixed with stems of reed (Phragmites communis), the most important herb in all but one transect (Tables 7 and 8). In Scharf et al. (in press) it was hypothesized that the reed stands may be resistant to ring-billed gull puddling, but this was disproved in 1977 by the finding of high percentages of bare area and low percent cover (Table 27). It was also seen in the high importance value of pigweed (Chenopodium album) which replaces reed on one transect on Moon Island (RBG-1, Table 7) and in the high importance value for stinging nettle (Urtica dioica) on Southwest Neebish Island (RBG-1, Table 8). Both of these islands also had woody plants present in the 17 m^2 quadrats (Tables 7 and 8). The larger quaking aspen (Populus tremuloides) on Moon Island were cut by beavers (Castor canadensis), providing additional gull nesting habitat. Moon Island also had an increase in ring-billed gull nesting area of 72 percent and an increase of 691 nests (19 percent) due primarily to the lower water levels. The corresponding increases for Southwest Neebish Island were 79 percent more nesting area and 1135 nests (90 percent). Nest densities of ring-billed gulls on these two sites were 0.73 nests/per m^2 and 0.81 nests/per m^2 and 0.81 nests/per m^2 for Moon and Southwest Neebish Islands, respectively. These values showed very dense nesting.

Site 8. Southeast Neebish Island

22. Location: 46°14' N., 084°07' W., a large dredged material island 19.5 km northeast of Pickford, Michigan (Figure 8).

Species and Number of Nests:

common terns:	1976-136
	1977-45
ring-billed gulls:	1976-49
	1977-55
herring gulls:	1976-1

Colony Size: common terns: both years 0.3 ha
ring-billed gull: both years 0.04 ha

History: The date of construction of this island was unknown.

Table 7

Moon Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	RBG-1[1]	RBG-2	RBG-3	RBG-4
1 m^2 Quadrats*	(24)	(2)	(9)	(4)
Witch-grass	98.3	-	-	-
Common milkweed	7.1	-	-	-
Sedge	-	-	5.6	-
Pigweed	105.4	-	16.5	-
Thoroughwort (*Eupatorium perfoliatum*)	-	-	12.9	-
Reed-meadow grass (*Glyceria grandis*)	-	-	56.5	-
Spotted touch-me-not	-	-	4.3	-
Rush	-	-	7.6	-
Pineapple-weed	-	-	4.3	-
White melilot	12.4	-	-	-
Reed (*Phragmites communis*)	69.2	-	105.1	-
Common plantain	-	-	10.7	-
June grass	-	-	20.4	-
Tall cinquefoil (*Potentilla arguta*)	-	-	4.3	-
Red clover	-	-	9.5	-
Stinging nettle (*Urtica dioica*)	7.8	-	32.8	-
Common mullein (*Verbascum thapsus*)	_	_	9.4	-
16 m^2 Quadrats*				
Red-osier dogwood (*Cornus stolonifera*)	-	-	-	59.3
Quaking aspen (*Populus tremuloides*)	-	96.4	-	-
Peach-leaved willow (*Salix amygdaloides*)	-	-	-	240.6
Red-berried elder (*Sambucus pubens*)	-	203.6	-	-

*Sample sizes are indicated in parenthesis. 1. RBG = ring-billed gull.

Table 8

Southwest Neebish Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	RBG-1
1 m^2 Quadrats*	(15)
Reed	187.4
Stinging nettle	112.6
16 m^2 Quadrats*	(2)
Red-osier dogwood	31.7
Sandbar willow	220.6
Red-berried elder	47.7

*Sample sizes are indicated in parenthesis.

1. RBG = ring-billed gull.

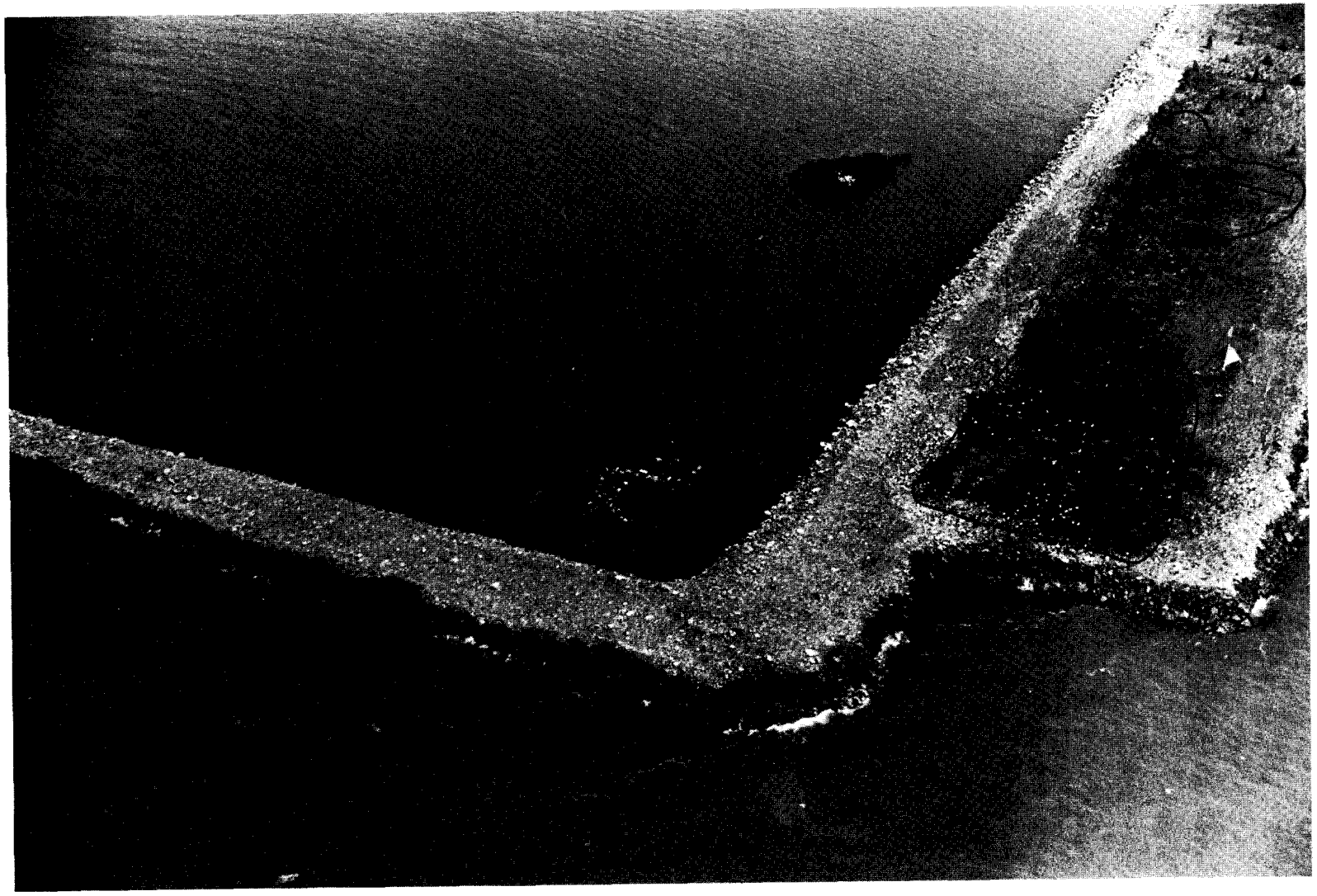


Figure 8. Southeast Neebish Island showing colonies of common terns and ring-billed gulls and vegetation sampling transects

Nesting Success: No unusual mortality was noted in either species. The common terns appeared to fledge most of their young, but the retardation by three to four weeks of the ring-billed gulls usually indicated poor survival of chicks.

23. Habitat: June grass (Poa pratensis) was the most important species among a sparse herb and grass community at this site (Table 9). The percent coverage (70 percent and 73 percent) for each species, shown in Tables 26 and 27, was biased by high density of the grasses, and did not reflect the lack of broadleaf shaded nesting cover visually evident. The island was composed of chipped igneous rock that was covered with a thin layer of soil. It was probable that the June grass was planted soon after construction and that the rocky surface resisted further plant succession. This feature seemed to make the area marginally attractive to ring-billed gulls and common terns, although they nested on bare rock and sand elsewhere in the Great Lakes. The marginality of the habitat was emphasized by the decrease in number of common terns in 1977 and by the low density of ring-billed gulls (0.13 nests per m^2) which led to widely asynchronous hatching and diminished nesting success.

Site 9. Willow Island

24. Location: 44°34' N., 088°00' W., a small dredged material island 2.3 km north of Green Bay, Wisconsin (Figure 9).

Species and Number of Nests:

black-crowned night herons:	1976-46	
	1977-224	
cattle egrets:	1977-15	
herring gulls:	1976-9	
	1977-16	

Colony Size: Total island: 1976- 0.18 ha
1977- 0.25 ha

History: The date of construction of this island was unknown, but was believed to have been built in the early decades of this century.

Table 9

Southeast Neebish Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	CT[1]	RBG-1[2]
1 m^2 Quadrats*	(10)	(10)
Common winter-cress	-	9.6
Black mustard (Brassica nigra)	13.1	46.6
Pickpocket (Capsella bursa-pastoris)	-	6.9
Pigweed	-	2.4
Field daisy	22.1	9.1
Fleabane (Erigeron philadelphicus)	-	2.2
Common timothy	34.8	42.1
June grass	190.8	150.8
Smartweed	-	2.6
Sheep-sorrel (Rumex acetosella)	-	16.8
Common dandelion	-	8.2
Field penny-cress (Thlaspi arvense)	4.6	2.5
Yellow clover	6.0	-
Red clover	28.4	-

*Sample sizes are indicated in parenthesis.

1. CT = common tern.

2. RBG = ring-billed gull.

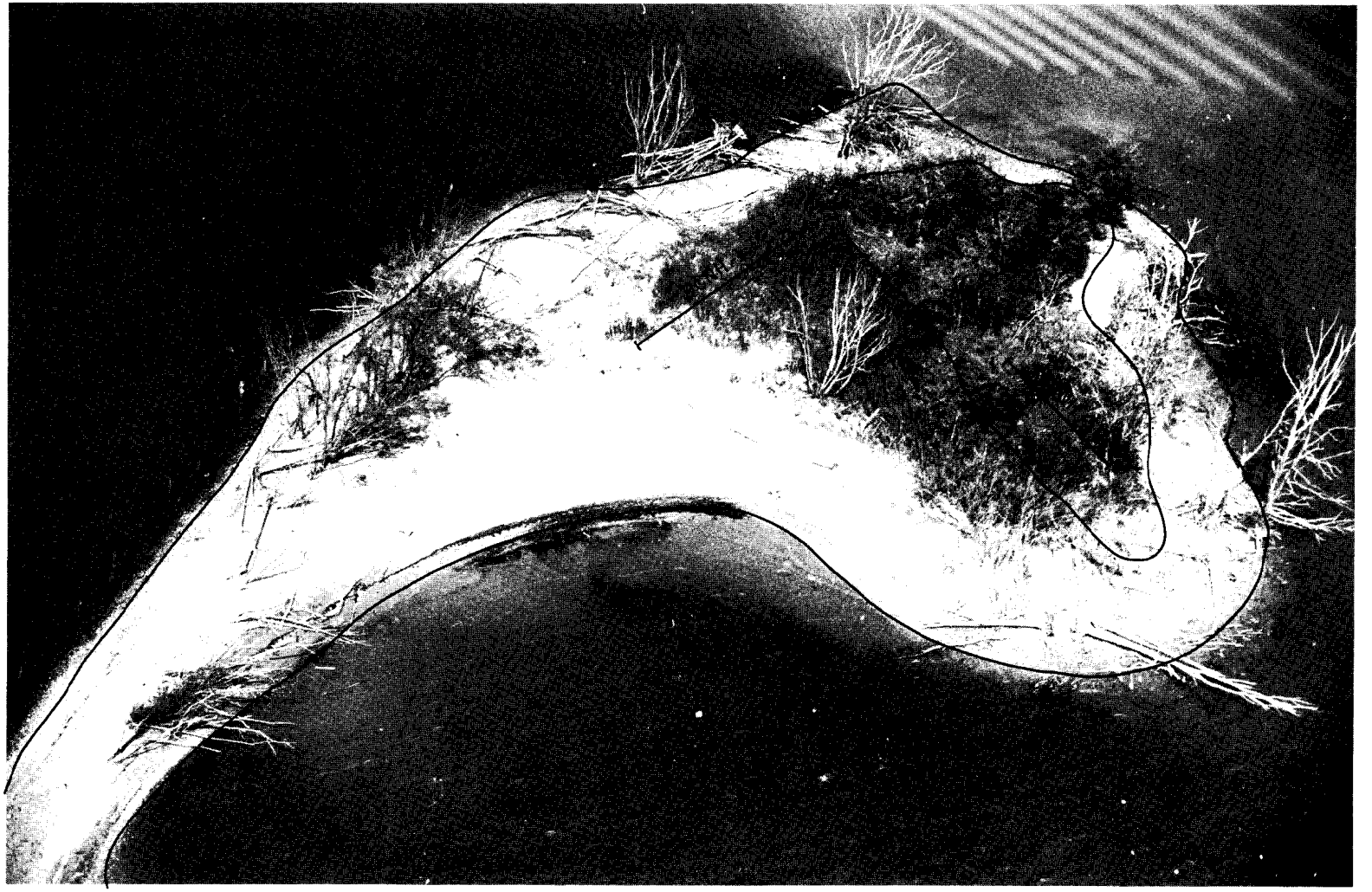


Figure 9. Willow Island showing colonies of black-crowned night herons, cattle egrets, and herring gulls and vegetation sampling transects

Nesting Success: The herring gulls produced only 0.33 fledglings per nest in 1976 (Scharf et al. in press) and similar low reproductive success was evident in 1977 because of excessive human disturbance. The black-crowned night herons produced 1.7 birds per nest in 1976 (Scharf et al. in press) and late nesting in 1977 was still in progress when this report was being written.

25. Habitat: The most important vegetation was the two species of willow which supported the nest trees (Table 10). This shrub and young tree community developed beyond that of any other dredged material colonial site in the U. S. Great Lakes. Hypothetically, if plant succession continues, this site would become suitable for tree nesting species such as great blue herons and great egrets some time in the future.

Site 10. Lone Tree Island

26. Location: 44°34' N., 088°00' W., a small rubble and dredged material island 2.1 km north of Green Bay, Wisconsin (Figure 10).

Species and Number of Nests:

common terns:	1976-100
	1977-108
herring gulls:	1976-3
	1977-2
ring-billed gulls:	1976-213
	1977-374

Colony Size: common terns, both years, 0.11 ha
ring-billed gulls, both years, 0.23 ha

History: The date of construction was unknown, but probably dated back to original dredged material deposits early in the century which were subsequently overlain with concrete and brick rubble. The common tern colony has been present for at least 15 years. There were 103 nests counted on the island in 1969. The highest number was an estimated 120 nests in 1972 and 1974. Ring-billed gulls first nested on the north end of the island in 1969, and four nests were again observed in 1972. By 1974 there were 30 nests, half on the north side

Table 10

Willow Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	BCNH-1[1]	BCNH-2	BCNH-3
1 m^2 Quadrats*	(10)		
Sandbar willow	300	-	-
16 m^2 Quadrats*		(5)	(5)
Box elder (*Acer negundo*)		7	8
Red-osier dogwood		-	7
Eastern cottonwood (*Populus deltoides*)		95	30
Peach-leaved willow		42	68
Sandbar willow		155	186

*Sample sizes are indicated in parenthesis.

1. BCNH = black-crowned night heron.

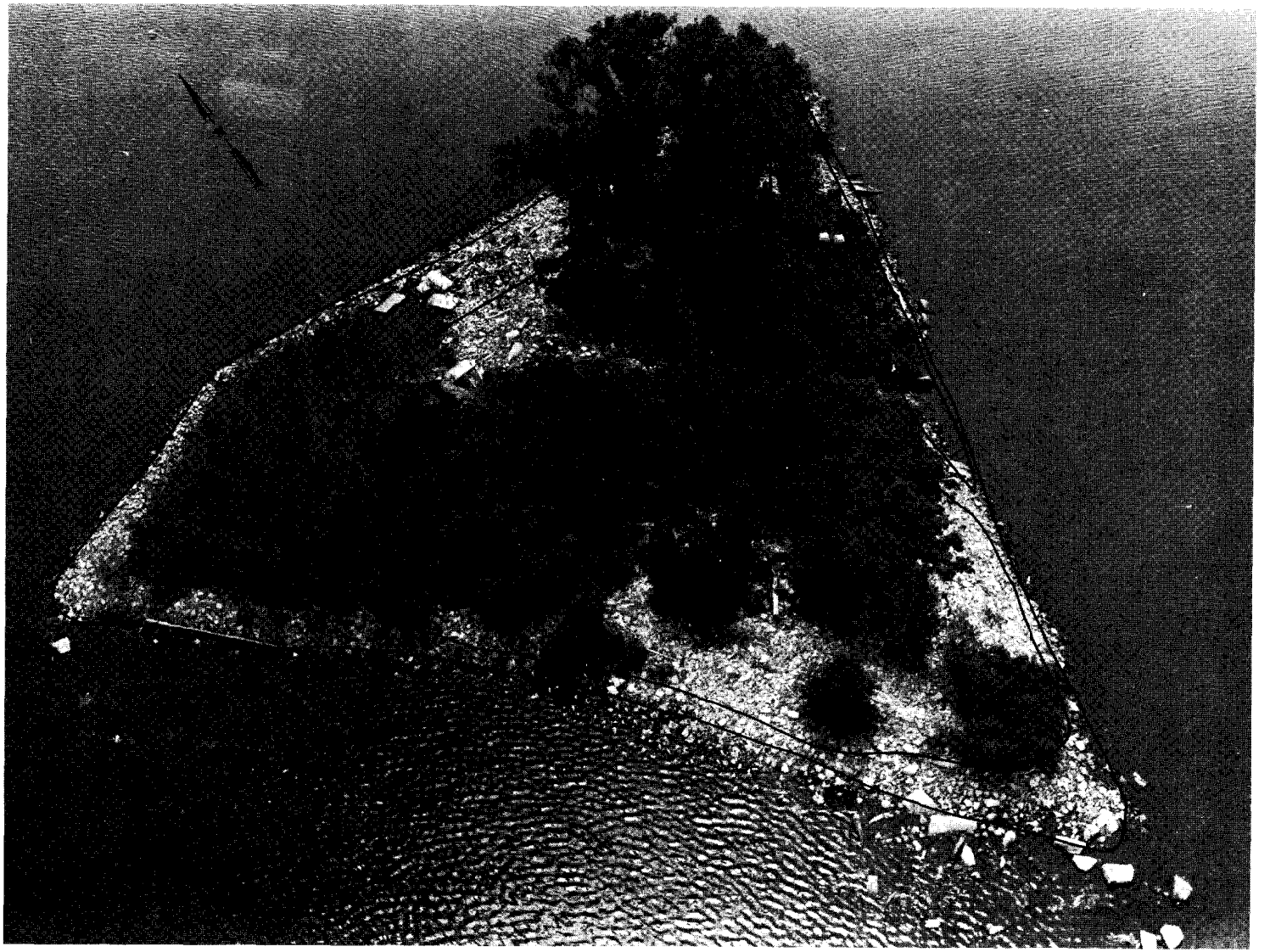


Figure 10. Lone Tree Island showing colonies of common terns and ring-billed gulls and vegetation sampling transects

and half on the southeast side. The number of nests increased to 87 in 1975. The ring-billed gull colony has continued to increase and the common terns have decreased or remained stable.

Nesting Success: (1976 only)

common terns, 0.66 per nest
herring gulls, 2.33 fledged per nest
ring-billed gulls, 0.84 per nest.

27. Habitat: The vegetation was a mix of herbaceous species with the greatest importance being on wild cucumber (Echinocystis lobata) and spotted touch-me-not (Impatiens capensis) (Table 11) which formed dense mats. Although the habitat, which had its continuity broken by rubble, appearedtoo heavily vegetated for optimum utilization by either ring-billed gulls or common terns, they both appeared to do well. Both of the important plant species mentioned above became most conspicuous later in the season, and probably the vegetation community first found by the birds during April and May was radically different than that shown in Table 11.

Site 11. South Manitou Island

28. Location: 45°03' N., 086°05' W., the northeast tip of a large natural island, 9.5 km west of Glen Arbor, Michigan (Figure 11).

Species and Number of Nests:

herring gulls: 1976-428
1977-470
ring-billed gulls: 1976-4060
1977-2686

Colony Size: herring gulls: 3.3 ha
ring-billed gulls: 2.2 ha

History: This has been documented as one of the largest gull colonies in Lake Michigan (Scharf, 1971b). Scharf and Shugart (1975) documented the relative stability of the herring gull colony over a 6-year period. In recent years the ring-billed gull colony declined from 6000 in 1969 to 2686 in 1977 due to excessive human disturbance, red fox (Vulpes vulpes) predation, and changes in vegetation structure

Table 11

Lone Tree Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	CT[1]	RBG[2]
1 m^2 Quadrats*	(10)	(13)
Common burdock (Arctium minus)	-	15
Common milkweed	8	-
Pigweed	22	6
Canada thistle	4	6
Red-osier dogwood	7	-
Cruciferae unidentified	-	-
Wild cucumber (Echinocystis lobata)	129	91
Spotted touch-me-not	44	12
Morning-glory (Ipomoea sp.)	13	-
Spiked loosestrife (Lythrum salicaria)	-	7
Virginia creeper (Parthenocissus quinquefolia)	-	19
Smartweed	-	77
Common elder (Sambucus canadensis)	14	-
Bittersweet	6	51
Stinging nettle	58	11

*Sample sizes are indicated in parenthesis.

1. CT = common tern.

2. RBG = ring-billed gull.

Figure 11. South Manitou Island showing colonies of ring-billed gulls and herring gulls and vegetation sampling transects

(Shugart, 1976 and Scharf, et al. in press)

Nesting Success: Herring gulls had very low success and few fledged in 1976 due to fox predation; and had normal fledging rate in 1977. Ring-billed gulls did not fledge in 1976 due to foxes. Fledging rate was near normal in 1977 although the colony was 60 percent smaller than it was in 1971.

29. Habitat: The herring gulls were found in two distant grassy vegetations. The lakeward area was characterized by beach grass (Ammophila breviligulata) with the highest importance value (HG-2, Table 12) in this blowing dune-sand association. The other was an inward, more heavily fertilized and less wind-blown area where brome grass (Bromus tectorum) was the most important species (HG-1 Table 12). Both of these vegetations were stable, except where human traffic disturbed the beach grass. Some herring gulls also nested on bare beach sand in this colony.

30. The ring-billed gulls over a monitored period of 12 years have killed much of the woody vegetation through the action of feces and feet. In response to the destruction of the woody vegetation and human disturbance the colony moved to more vegetated portions which deteriorated rapidly to the extent that many gulls nest on bare ground. Coverage (Table 27) varied from 3 percent to 37 percent with the lower figure being typical of the main nesting area. The porous sands coupled with the mechanical and chemical inputs from the gulls made most of the plant species (Table 12) except sparse grasses show stress during the nesting season. Revegetation of the abandoned ring-billed gull nesting area appeared to be slowly re-occurring as is typical of dune areas. The abatement of fox predation in 1977 and control of human intrusions by the National Park Service should aid in the stabilization of this declining colony, but the continued destruction of the ring-billed gull habitat by the gulls' actions ultimately will determine the stable population level.

Site 12. Bellows Island

Table 12

South Manitou Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	HG-1[1]	HG-2	RBG-1[2]	RBG-2	RBG-3
1 m^2 Quadrats*	(11)	(10)	(12)	(10)	(10)
Agropyron (Agropyron dasystachyum)	-	45	54	61	-
Beach grass (Ammophila breviligulata)	-	175	177	204	-
Wormwood	36	5	-	-	-
Common milkweed	-	-	6	-	-
Brome grass (Bromus tectorum)	129	-	-	36	92
Sea rocket (Cakile edentula)	-	68	33	-	-
Pigweed	4	-	-	-	54
Creeping savin (Juniperus horizontalis)	-	-	-	-	46
Beach-pea (Lathyrus japonicus)	-	8	-	-	-
White champion (Lychnis alba)	4	-	-	-	-
White melilot	10	-	-	-	-
Canada bluegrass (Poa compressa)	77	-	-	-	-
Sand cherry (Prunus pumila)	-	-	8	-	-
Poison ivy (Rhus radicans)	-	-	21	-	-
Sheep-sorrel	16	-	-	-	-
Tumble-mustard	7	-	-	-	38
Field penny-cress	12	-	-	-	72
Goats'-beard (Tragopogon major)	4	-	-	-	-

*Sample sizes are indicated in parenthesis.

1. HG = herring gulls.

2. RBG = ring-billed gulls.

31. Location: 45°06'N., 085°34' W., a natural island 5 km east of Northport, Michigan (Figure 12).

Species and Number of Nests: herring gulls: 1976-728
1977-705

Colony Size: 1976- 1.86 ha
1977- 2.2 ha

History: This large herring gull colony dates back at least to the early decades of this century. James P. Ludwig (1977, personal communication) had records of banding over 2500 chicks here in the early 1960's. A decline coupled with severe pesticide contamination (Ludwig and Tomoff, 1966) has brought about an apparent stabilization for the past 10 years at present population levels.

Nesting Success: The stable lowered population consistently produced an average of 0.70 fledglings per nest during the past eight years.

32. Habitat: The mix of trees, shrubs, and herbs (Table 13) in different zones of the island indicated the wide diversity of nesting habitat to which herring gulls adapt. Sandbar willow and red-berried elder (Sambucus pubens) were the most important shrub species. Witchgrass and brome-grass appeared to be the most important herbs, but the sampling bias favoring large numbers of small stemmed species greatly exaggerated their importance over visual evaluations. No clear trends appeared among the other species, although each transect showed a different mix of species usually associated with zonation of the soils and soil moisture. The vegetation on this island was responsive to changes in the water levels of the Great Lakes. In high-water years, the vegetation type of transect 4 (Table 13) expanded and large areas of stinging nettle were found in the area of transect 3 (Table 13).

Site 13. High Island

33. Location: 45°45' N., 085°40' W., the northern tip of a large natural island 4 km west of Beaver Island, Michigan (Figure 13).

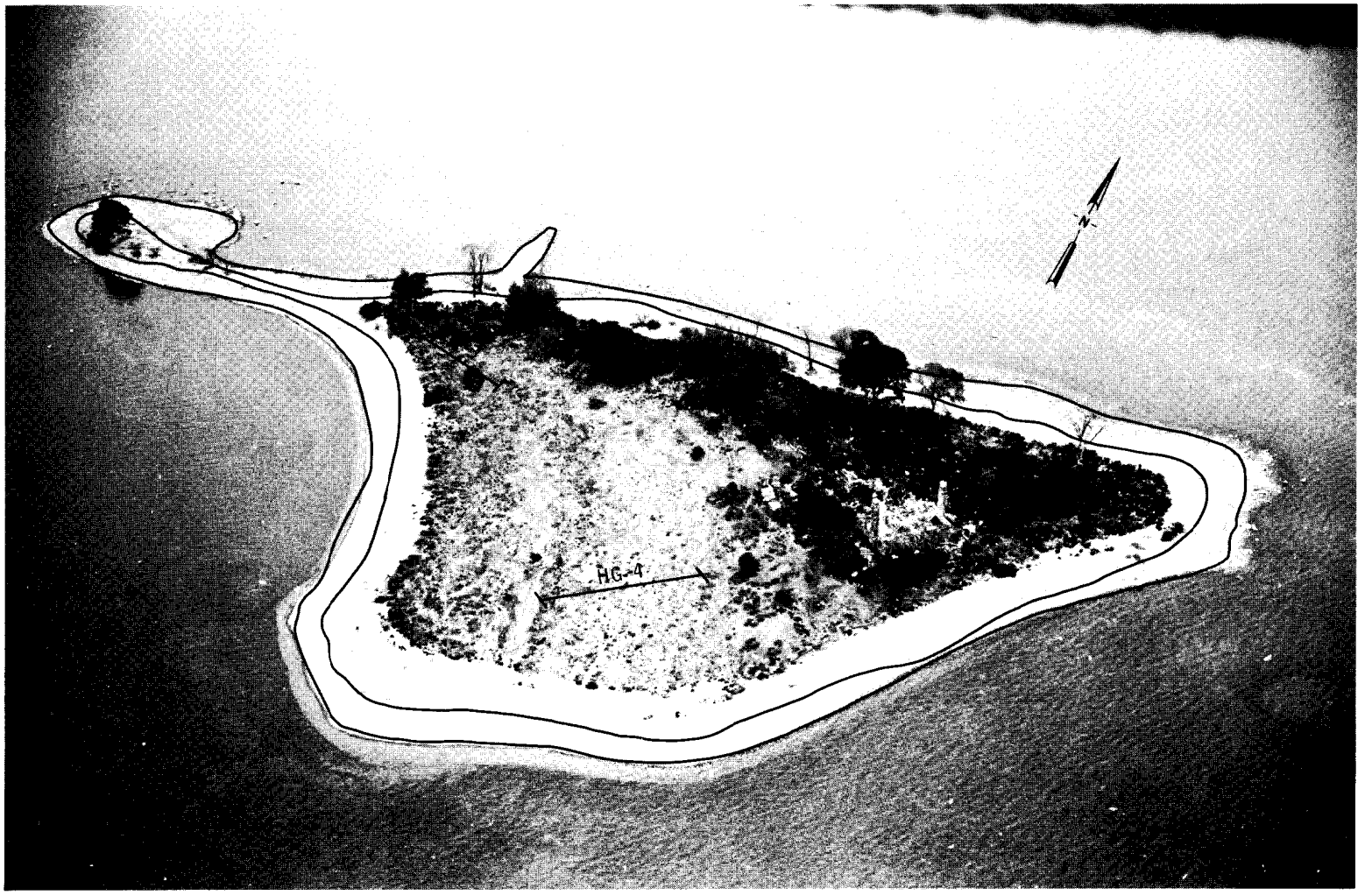


Figure 12. Bellows Island showing a herring gull colony and vegetation sampling transects

Table 13

Bellows Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	HG-1[1]	HG-2	HG-3	HG-4
16 m^2 Quadrats*	(10)	(1)	-	-
Sandbar willow	-	300	-	-
Red-berried elder	257	-	-	-
Choke cherry (Prunus virginiana)	43	-	-	-
1 m^2 Quadrats*	(10)	(3)	(10)	(17)
Witchgrass	-	-	180	03
Alyssum (Alyssum alyssoides)	-	-	20	-
Ragweed	-	-	3	31
Common burdock	8	-	4	-
Common winter-cress	-	-	8	-
Brome-grass	72	-	-	3
Pickpocket	-	-	-	9
Spotted star-thistle (Centaurea maculosa)	-	-	16	28
Pigweed	15	15	-	21
Wildrye (Elymus canadensis)	-	-	-	4
Herb-Robert (Geranium robertianum)	6	19	3	-
Gill-over-the-ground (Glecoma hederacea)	6	10	14	15
Masterwort (Heracleum maximum)	-	25	-	-
Spotted touch-me-not	-	39	-	-
Lettuce	-	7	-	13
Common motherwort (Leonurus cardiaca)	11	-	-	-
White campion	41	-	27	3
Catnip (Nepeta cataria)	-	-	8	42

*Sample sizes are indicated in parenthesis.

1. HG = herring gulls.

Table 13 (Concluded)

Bellows Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	HG-1[1]	HG-2	HG-3	HG-4
1 m^2 Quadrats*	(10)	(3)	(10)	(17)
Poke (Phytolacca americana)	7	-	-	-
June grass	11	-	-	45
Smartweed	-	9	-	23
Silverweed	-	-	-	13
Sandbar willow	-	123	-	-
Red-berried elder	56	-	-	-
Bittersweet	16	20	-	5
Stinging nettle	50	36	14	40

*Sample sizes are indicated in parenthesis.

1. HG = herring gulls.

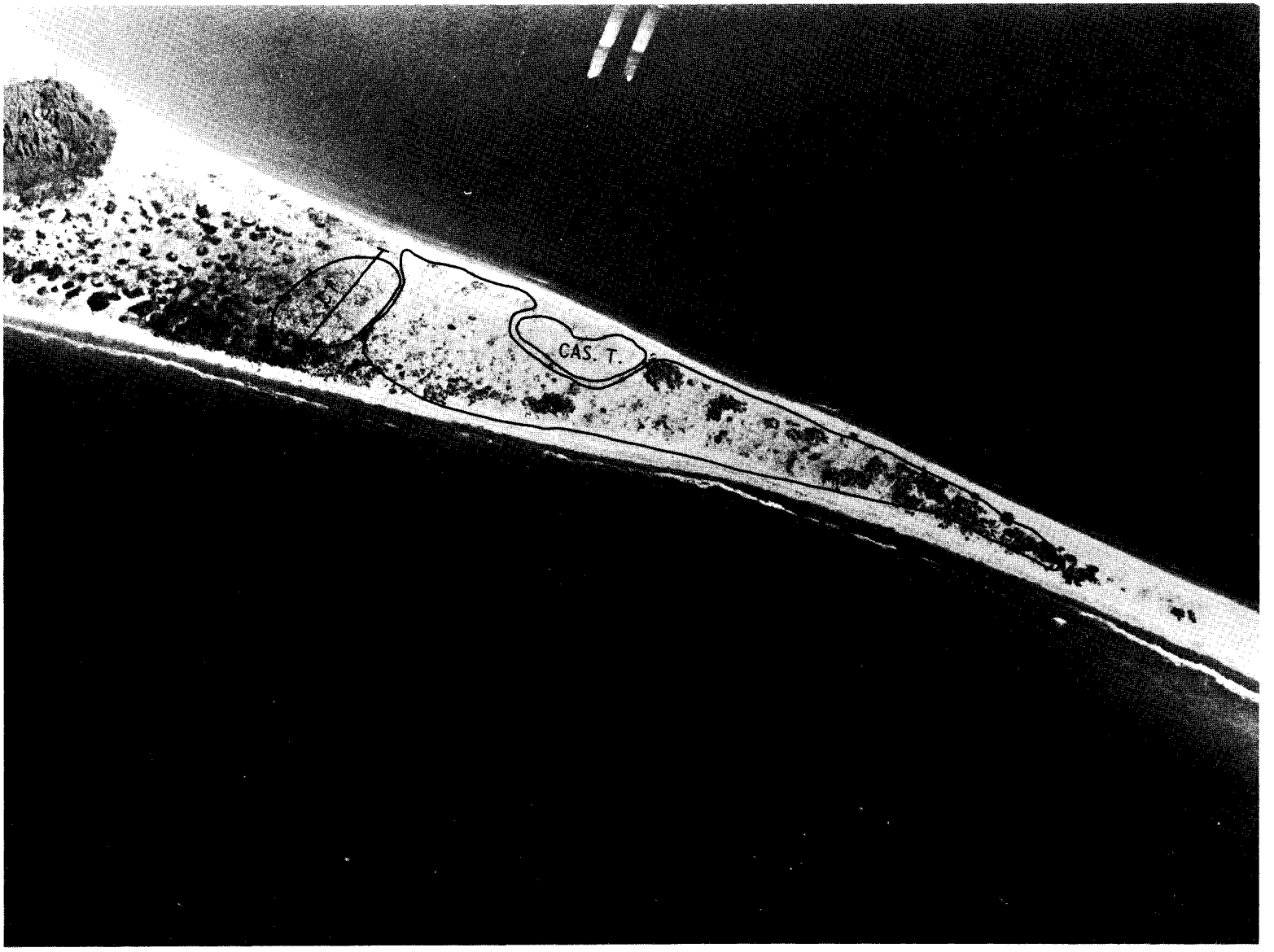


Figure 13. High Island showing colonies of ring-billed gulls, Caspian terns, and common terns and vegetation sampling transect

Species and Number of Nests:

common terns:	1976-411
	1977-87
ring-billed gulls:	1976-3313
	1977-3442
Caspian terns:	1976-63
	1977-116
herring gulls:	1976-4
	1977-7

Colony Size:

common terns:	1976- 0.117 ha
	1977- 0.152 ha
Caspian terns:	1976-0.047 ha
	1977-0.6 ha
herring gulls:	nests scattered
ring-billed gulls:	1976-1977 0.616 ha

History: Hatt et al. (1948) found Caspian and common terns nesting on a High Island gravel bar or shoal about 300 m north of the northeast point. There were 800 pairs of common terns nesting on the shoal in 1962 (Ludwig 1962). High Island Shoal was under water in 1960 (Ludwig 1962) and in 1974-74. Gulls and terns probably began nesting on the island in the 1960's in response to a cyclic increase in water levels inundating nesting areas such as High Island Shoal. Ludwig (1962) documented the onset of nesting of ring-billed gulls and common terns on the island. No ring-billed gulls nested on the island in 1960 or 1962, but 20 pairs nested there in 1961. In 1960, 1962, and 1963, there were 500, 0, and 75 nesting pairs of common terns, respectively. Investigators from Central Michigan University, Mount Pleasant, Michigan, worked with the Caspian terns that were nesting on the island in the late 1960's, but Scharf (1971a) was the first to document the nesting of Caspian terns. All species were preyed upon by coyotes (Canis latrans) during 1975, causing zero productivity and declines in 1976 returning nesting birds (Shugart in Scharf et al. in press).

Nesting Success: Reports (Shugart, Appendix E) of mortality caused by recreational boaters were the only inferences with

nesting in 1977. The coyote predation abated in 1976 and was unimportant in 1977.

34. Habitat: Beach grass and agropyron (Table 14) had the highest importance values and typified both the common tern and ring-billed gull areas as dune-sand plant associations. The importance value of red-osier dogwood (Cornus stolonifera) in the ring-billed gull colony was an indication of the tolerance of shrubs by this bird species at this site. The average percent coverage (30 percent, Table 26) in the ring-billed gull transects illustrated well the large amount of bare ground commonly found in nesting areas of this species. The coverage in the common tern area (43 percent, Table 27) and the lack of quantifiable vegetation in the Caspian tern area were characteristic of the habitats of these species at other sites. The subsidence of lake water levels reduced erosion and exposed the adjacent High Island Shoals (Table 1), but otherwise has not affected this site.

Sites 14 and 15. East Grape Island and West Grape Island

35. Location: 45°47' N., 085°24' W., two natural islands, designated East and West Grape Islands, part of a peninsula extending 100 m west of the southwest corner of Hog Island, Michigan (Figure 14, East Grape Island).

Species and Number of Nests:

East Grape Island:	common terns:	1976-0
		1977-11
	herring gulls:	1976-1
		1977-4
	ring-billed gulls:	1976-1188
		1977-1278
West Grape Island:		
	great blue heron:	1976-5
		1977-3
	herring gulls:	1976-5
		1977-6
	ring-billed gulls:	1976-3979
		1977-3660

Table 14

High Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	CT[1]	RBG-1[2]	RBG-2
1 m^2 Quadrats*	(35)	(9)	(8)
Agropyron	91	-	-
Beach grass	90	216	240
Worm wood (*Artemisia absinthium*)	31	-	-
Harebell (*Campanula rotundifolia*)	11	-	-
Red-osier dogwood	4	84	60
Wild rye	14	-	-
Sand cherry	13	-	-
Poison ivy	3	-	-
Rose (*Rosa* sp.)	6	-	-

*Sample sizes are indicated in parenthesis.

1. CT = common tern.
2. RBG = ring-billed gull.

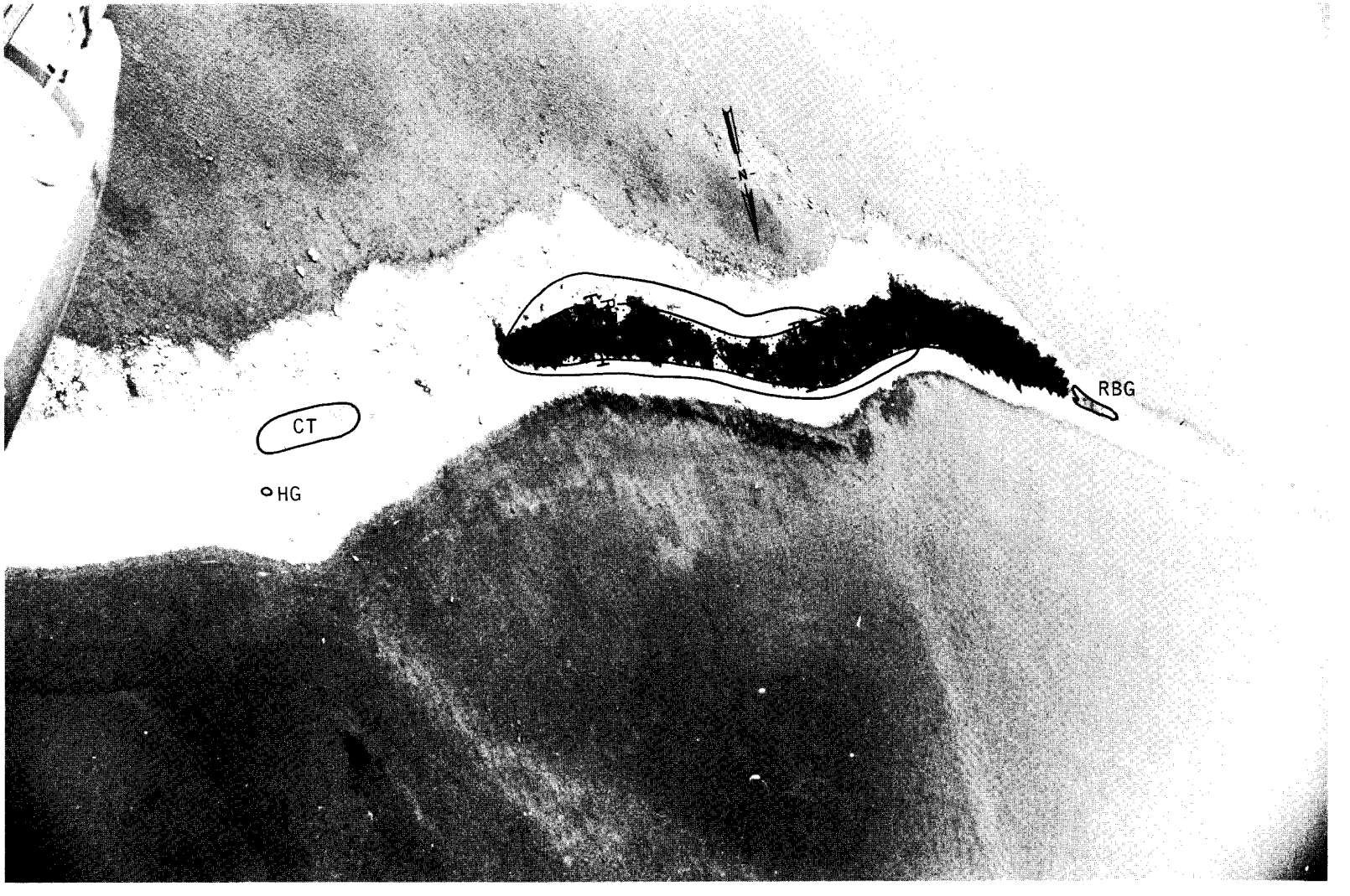


Figure 14. East Grape Island showing colonies of herring gulls, ring-billed gulls, and common terns and vegetation sampling transects

Colony Size: East Grape Island

common tern:	1976-none
	1977-0.01 ha
herring gulls:	not aggregated
ring-billed gulls:	1976-0.15 ha
	1977-0.2 ha
West Grape Island	
herring gulls:	not aggregated
ring-billed gulls:	1976-0.6 ha
	1977-0.86 ha

History: Ring-billed gulls were reported nesting here by Scharf (1971a). Other surveys (Hatt et al. 1948) may have observed the islands during low water years when they were connected to Hog Island and may not have had colonial nesting birds.

Nesting Success: Productivity appeared good during both seasons (Appendix E).

36. Habitat: Both shrub and herb communities were sampled (Tables 15 and 16) and exhibited a wide diversity of species with choke cherry (Prunus virginiana) and red-osier dogwood having the highest importance values of the shrubs or East and West Grape Islands respectively. The herb communities were found to be very diverse. Many quadrats were bare of herb cover due to the trampling and over-fertilization caused by the ring-billed gulls. The affect of the ring-billed gulls' activities was also indicated by vegetation coverage of one percent in the nesting area which sharply contrasts with the 54 percent vegetation coverage west of the nesting area.

Site 16. Hat Island

37. Location: 45°47' N., 085°18' W., a natural island 20 km northeast of Beaver Island, Michigan.

Species and Number of Nests: (Figure 15)

great blue heron:	1976-3
	1977-none
Caspian tern:	1976-730
	1977-686
herring gulls:	1976-690
	1977-603

Table 15

East Grape Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	RBG-1[1]	RBG-2
16 m^2 Quadrats*	(4)	(4)
Juneberry (*Amelanchier laevis*)	-	20
Red-osier dogwood	158	129
Ninebark (*Physocarpus opulifolius*)	27	-
Sandbar willow	-	44
Red-berried elder	20	-
Bittersweet	-	20
Arborvitae (*Thuja occidentalis*)	64	-
River-bard grape (*Vitus riparia*)	32	86
1 m^2 Quadrats*	(9)	(8)
Common milkweed	-	68
Meadow grass (*Poa* sp.)	-	39
Cinquefoil (*Potentilla norvegica*)	-	13
Poison ivy	-	41
Yellow-cress (*Rorippa islandica*)	-	10
Raspberry	-	41
Yellow-dock (*Rumex crispus*)	-	10
False Solomon's-seal (*Smilacina stellata*)	-	79

*Sample sizes are indicated in parenthesis.

1. RBG = ring-billed gulls.

Table 16

West Grape Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	RBG-1[1]	RBG-2	RBG-3	AREA WITH NO NESTS
16 m^2 Quadrats*	(4)	(7)	(6)	(12)
Red-osier dogwood	-	10	23	11
White ash (Fraxinus americana)	25	12	-	36
Morning glory	-	-	50	-
Choke cherry	55	127	125	171
American mountain ash (Pyrus americana)	52	-	-	-
Staghorn sumac (Rhus typhina)	-	-	24	-
Gooseberry (Ribes hirtellum)	12	25	-	6
Raspberry	-	-	-	5
Red-berried elder	58	34	20	35
Arborvitae	66	62	32	28
Riverbank grape	36	30	27	8
1 m^2 Quadrats*	(8)	(14)	(12)	(22)
Common burdock	-	-	-	3
Wormwood	-	147	-	49
Sedge	-	30	-	-
Clovers (Galium aparine)	-	-	-	22
Herb-Robert	-	35	-	48
Rough avens (Geum virginianum)	-	60	-	-
Gramineae (unidentified)	-	-	-	24
Liverleaf (Hepatica acutiloba)	-	-	-	11
Masterwort	-	-	-	3
Balsam (Impatiens sp.)	-	-	-	20

(Continued)

*Sample sizes are indicated in parenthesis.

Table 16 (Concluded)

West Grape Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	RBG-1[1]	RBG-2	RBG-3	AREA WITH NO NESTS
1 m^2 Quadrats*	(8)	(14)	(12)	(22)
Polypodiaceae (undentified)	-	-	-	4
Choke cherry	-	-	-	67
Poison ivy	-	-	-	5
Gooseberry	-	-	-	4
Raspberry	-	-	-	14
Yellow dock	-	30	-	-
Red-berried elder	-	-	-	15
False Solomon's-seal	-	-	-	11

*Sample sizes are indicated in parenthesis.

1. RBG = ring-billed gulls.

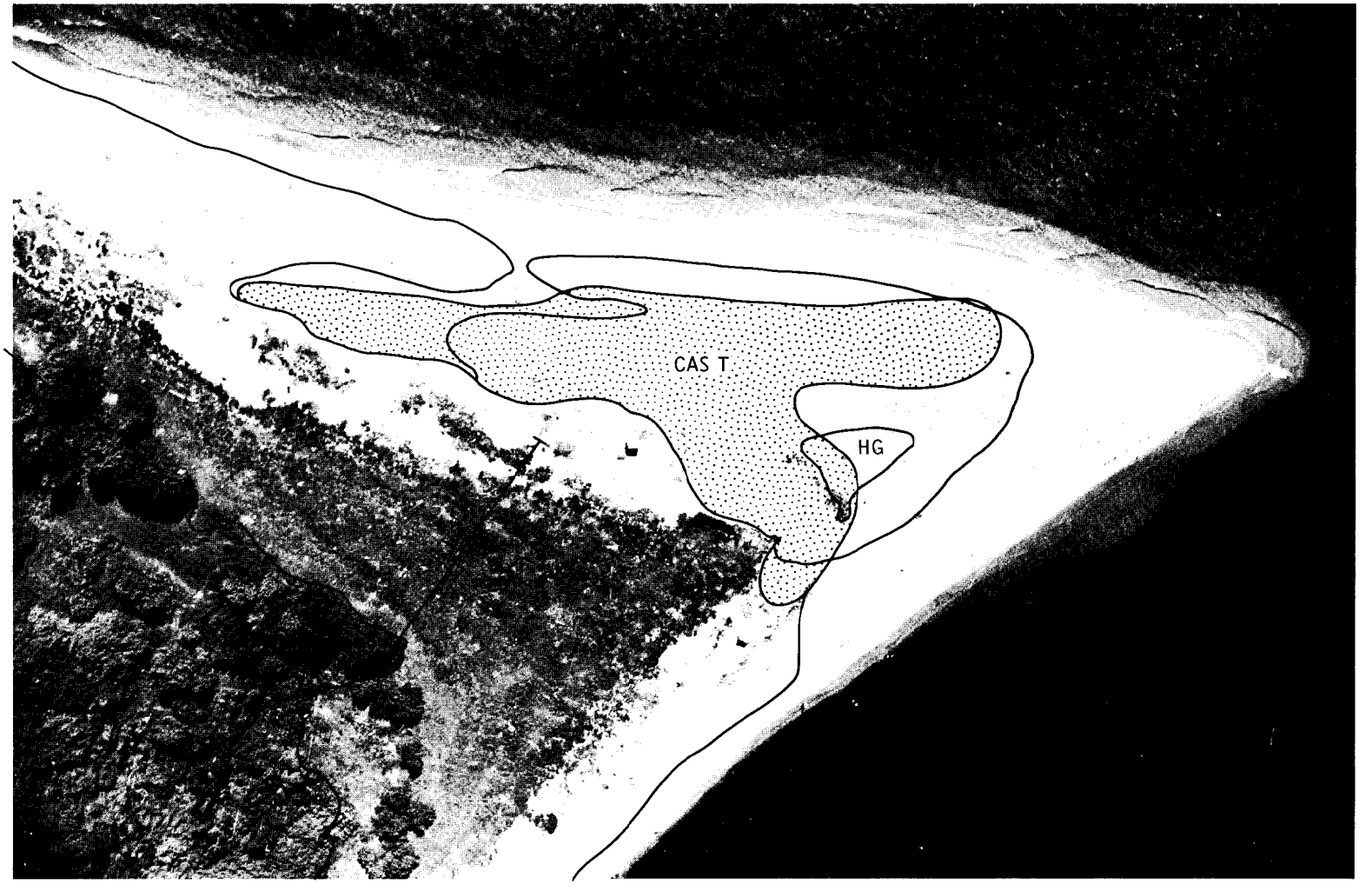


Figure 15. Hat Island showing colonies of herring gulls and Caspian terns and vegetation sampling transect

Colony Size: herring gulls: 2.3 ha each year

Caspian tern colony area shown on map (Shugart in Scharf et al. in press).

History: Hat Island and Shoe Island, which is 0.8 km south of Hat Island, have been used as a Caspian tern nesting site since 1896 (Ludwig, 1962). Lincoln(1926) banded herring gulls on Hat and Caspian terns on Shoe Island in 1927. Hatt et al. (1948) found great blue herons, herring and ring-billed gulls, and Caspian and common terns nesting on Hat Island. Ludwig (1962) and Scharf (1971a) also reported Caspian terns and herring gulls nesting here.

Nesting Success: Productivity of herring gulls seemed good both years, but Shugart (1977, personal communication) found many nearly fledged 1976 chicks dead on the island on his return during the 1977 season. An 11 percent reduction in herring gulls nesting in 1977 was attributed to disturbances associated with investigations during 1976 (Shugart, Appendix C). Caspian terns did well in 1976, but cannon netting in 1977 led to 65 percent abandonment of nests in late May and early June (Shugart, Appendix C).

38. Habitat: The herring gull area vegetation (Table 17) was very diverse and only brome-grass and common timothy (Phleum pratense) have an importance value above 50. Except for trails through grass and moderate fertilization, herring gulls seemed to have little effect on the surrounding vegetation. The habitat of Caspian terns had too few plants to warrant sampling, and was characterized by cobble beach stone which was arranged by winter lake storms and/or ice in drift rows. The terns seemed to prefer these ridges which were elevated, thus avoiding inundation during spring and summer, but still kept clear of interior island vegetation by the yearly cycle of weather . Great blue herons occupied one of the larger trees in 1976, but were absent in 1977.

Sites 17 and 18. Channel Island and Shelter Island

39. Location: 43°40' N., 083°49' to 50' W., two dredged material islands 2 km east of Bay City, Michigan (Figures 16 and 17).

Table 17

Hat Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	HG-1[1]	HG-2	HG-3	HG-4	HG-5	HG-6	HG-7
1 m^2 Quadrats*	(16)	(14)	(11)	(12)	(10)	(10)	(39)
Common yarrow	14	3	5	9	3	4	3
Witch-grass	5	-	-	-	-	85	-
Agropyron (Agropyron trachycaulum)	17	23	47	-	-	-	21
Wild columtrne (Aquilegia canadensis)	-	-	-	-	-	-	1
Common burdock	-	-	-	-	-	3	-
Wormwood	-	27	-	1	-	-	2
Chinese mustard (Brassica juncea)	11	9	-	16	7	-	-
Brome-grass	114	89	75	-	-	46	12
Harebell	-	-	-	-	-	-	2
Pickpocket	-	-	5	-	-	-	7
Field daisy	-	-	-	-	13	-	1
Red-osier dogwood	-	4	64	9	4	-	13
Clovers	-	-	-	1	-	14	7
Herb-Robert	-	-	7	7	13	-	2
Rough avens	5	-	-	1	4	-	-
Cow-cress (Lepidium campestre)	33	4	-	34	20	21	3
Poor-man's pepper (Lepidium virginicum)	2	3	-	-	7	-	-
White campion	5	24	5	9	-	-	7
Catnip	-	-	-	2	13	4	4
Parsnip (Pastinaca sativa)	-	-	46	46	27	18	12
Common timothy	28	-	-	36	94	9	86
Junegrass	47	79	25	37	18	46	60
Choke cherry	-	-	-	8	-	20	33

(Continued)

*Sample sizes are indicated in parenthesis.

Table 17 (Concluded)

Hat Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	HG-1	HG-2	HG-3	HG-4	HG-5	HG-6	HG-7
1 m^2 Quadrats*	(16)	(14)	(11)	(12)	(10)	(10)	(39)
Poison ivy	-	14	-	5	30	-	6
Staghorn sumac	-	-	-	-	-	-	4
Rose	-	10	-	-	13	4	5
Raspberry	-	-	5	6	-	-	8
Yellow-dock	1	-	13	21	9	-	2
Curly-leafed dock (Rumex mexicanus)	-	-	-	12	-	3	-
Red-berried elder	-	-	-	-	-	-	4
Night-flowering catchfly (Silene noctiflora)	-	4	-	18	-	-	1
Tumble-mustard	-	3	-	17	-	-	-
Fake Solomon's-seal	-	-	-	-	14	4	-
Common dandelion	+4	-	-	-	7	13	5
Common mullein	-	-	-	-	4	-	-

*Sample sizes are indicated in parenthesis.

1. HG = herring gull.

Figure 16. Channel Island showing colonies of black-crowned night herons, common terns, and ring-billed gulls and vegetation sampling transect

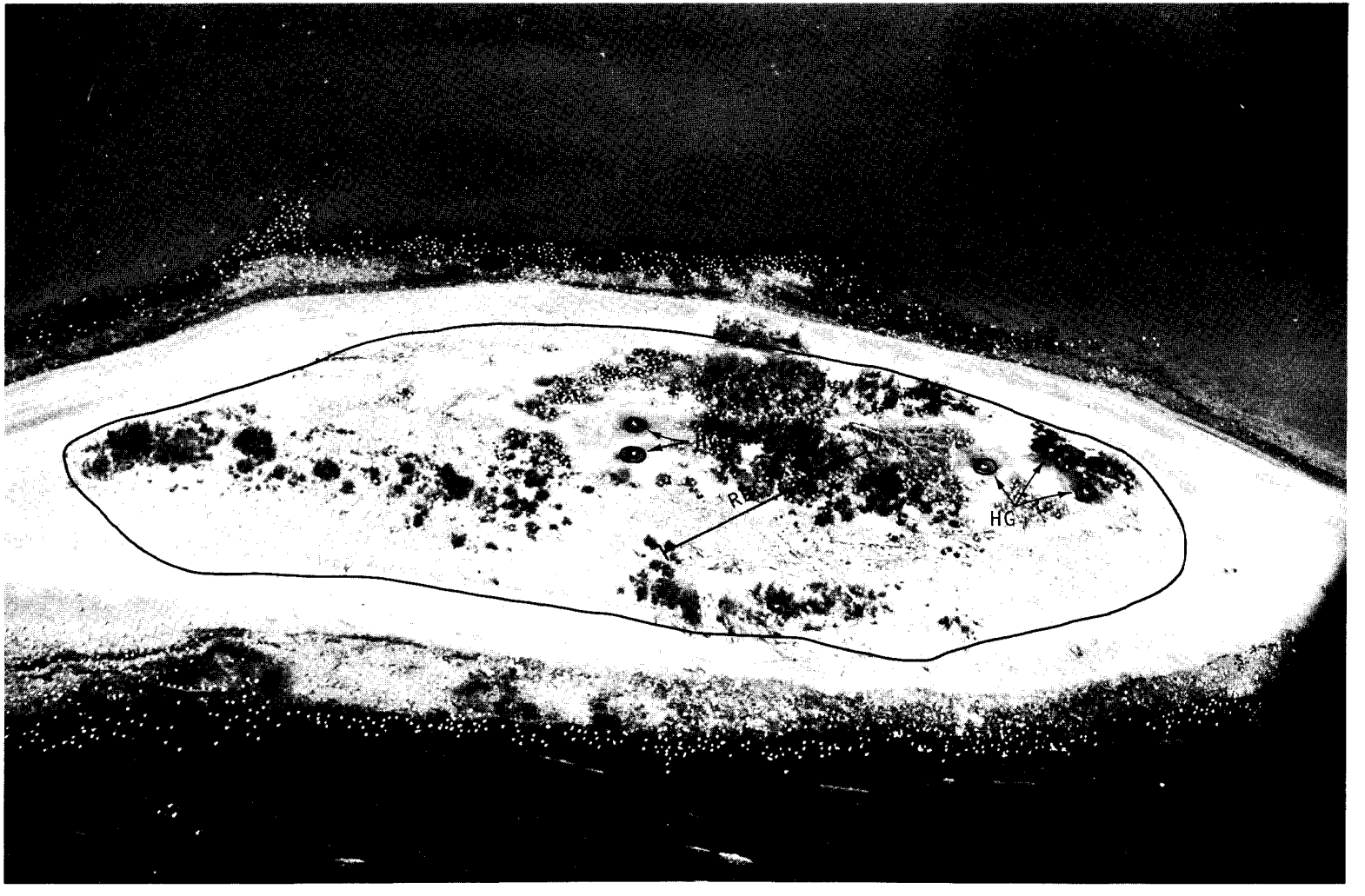


Figure 17. Shelter Island showing colonies of ring-billed gulls and herring gulls and vegetation sampling transect

Species and Number of Nests:

Channel Island:	black-crowned night herons:	1976-4 1977-16
Shelter Island:	black-crowned night herons:	1976-1 1977-none
Channel Island:	common terns:	1976-none 1977-64
Channel Island:	ring-billed gulls:	1976-2021 1977-1666
Shelter Island:	ring-billed gulls:	1976-2087 1977-1723

Colony Size: Channel Island: 0.41 ha

Shelter Island: 0.5 ha

History: The date of construction of the islands was unknown. Nesting of ring-billed gulls was documented by Scharf (1971a).

Nesting Success: Large numbers of chicks fledged from both these islands in 1976 and 1977. However, the low-lying nests were apparently inundated and eliminated by storms in both seasons, as evidenced by the windrows of eggs found washed up along the high water mark each year. The common terns and black-crowned night herons seemed successful, but several early incubating black-crowned night herons deserted Shelter Island in 1976.

40. Habitat: The stage of shrub development on the original dredged material islands, coupled with an intergradation of herb and bare sand on eroded and washed areas, allowed the colonization of these islands by the three species of birds with seemingly divergent habitat preferences. The common terns on Channel Island nested on bare sand. The ring-billed gulls nested on some bare sand, but mainly in yellow melilot (Melilotis officinalis), sandbar willow, and herbaceous habitat (Table 18), and the black-crowned night herons were in small (3.0 to 3.5 m), shrubby, eastern cottonwood (Populus deltoides) trees. The relatively high coverage values for the ring-billed gull area (Table 27) did not convey the subjective visual impression of the severe effect the birds have had on the vegetation.

Table 18

Channel Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	RBG-1
1 m^2 Quadrats*	(10)
Yellow melilot (Melilotus officinalis)	135
Sandbar willow	165

Table 19

Shelter Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	RBG-1
1 m^2 Quadrats*	(10)
Pigweed	37
Gill-over-the-ground	47
Yellow melilot	70
Sandbar willow	148

Table 20

Mud Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	RBG-1
1 m^2 Quadrats*	(15)
Brome-grass	13
Pickpocket	14
Pigweed	67
Lettuce	12

(Continued)

*Sample sizes are indicated in parenthesis. 1. RBG = ring-billed gull.

Table 20 (Concluded)

Mud Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	RBG-1[1]
1 m^2 Quadrats*	(15)
White melilot	150
Field penny-cress	42

Table 21

Grassy Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	RBG-1[1]	RBG-2	RBG-3
1 m^2 Quadrats*	(5)	(5)	(5)
Smartweed	300	-	-
Sandbar willow	-	300	-
Reed	-	-	300

Table 22

Toledo Harbor Dike

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	RBG[1]	CT[2]
1 m^2 Quadrats*	(5)	(5)
Common darnel (Lolium perenne)	300	-
Smartweed	-	300

*Sample sizes are indicated in parenthesis.

1. RBG = ring-billed gull.

2. CT = common tern.

Site 19. Mud Island

41. Location: 42°14' N., 083°08' W., a rip-rapped dredged material island 0.2 km east of Wyandotte, Michigan (Figure 18).

Species and Number of Nests: herring gulls: 1976-none
1977-2
ring-billed gulls: 1976-5040
1977-5290

Colony Size: 1.56 ha

History: The only published record of this colony was by Scharf (1971a) although James P. Ludwig (1977, personal communication) indicated the ring-billed gulls were long established there. U. S. Army Engineers District, Detroit, records indicate construction from 1959 to 1960. Ken Dalke (1976, personal communication) recalled large numbers of common terns nesting on Mud Island, although no ring-billed gulls, in the early years after its construction.

Nesting Success: High nest density of 0.52 nests per m^2 was indicative of the high reproductive potential per unit area for this species, even though moderate numbers of dead young were found in and along the periphery of the colony each season. The causes of the chick mortality were possibly human intrusions due to the proximity to an urban environment and marina.

42. Habitat: The lack of diversity (only six species, Table 20) of the herb community with white melilot having the highest importance value and field penny-cress (Thlaspi arvense) and pigweed with subordinate importance values were representative of the severe modification of the plant community caused by continuous long-term presence of ring-billed gulls. The high vegetation coverage of the tall (0.75 m) white melilot (77 percent, Table 28) indicated aerial coverage only and distorted the presence of large amounts of bare soil beneath these plants. High percentages of clay and muck in the original dredged material apparently allowed this site to re-vegetate with these guano-resistant plants each year. This vegetation cover during nesting and fledging seemed to contribute to the dense nesting and high productivity year after year. The gulls maintained their nesting area by preventing the

Figure 18. Mud Island showing a ring-billed gull colony and vegetation sampling transect

succession of woody species as has occurred on the western portion of this island. These young trees and shrubs on the western end of the island were at a stage where they could support black-crowned night herons and possibly great blue herons and common egrets if it were not for the human disturbance factor from the nearby urban area.

Site 20. Grassy Island

43. Location: 42°15' N., 083°07' W., a diked, dredged material island 2 km east of Wyandotte, Michigan (Figure 19).

Species and Number of Nests: No nesting 1976

common terns: 1977-20
all unsuccessful

ring-billed gulls: 1977-1644

Colony Size: 2.4 ha

History: Deposition of dredged material was still progressing at this site, and 1977 was the first year of colonial bird nesting.

Nesting Success: Large numbers of ring-billed gull chicks apparently fledged from this site, but many unsuccessful nests were found in the margins of the colony, and much late nesting or re-nesting was evident and presumed to be unsuccessful.

44. Habitat: Each of three separate transects was occupied by a single plant species. The 0.5 to 1.5 m tall sandbar willow and reed transects had the greatest nest density, and the smartweed (Polygonum lapathifolium) transect was just emerging during the nest building stage, giving that area an appearance of being nearly bare early in the season. A large bare alluvial crescent of sandy material can be seen in Figure 19 near the dredge dispersal pipe. No nesting was found outward from this 10 to 20 m fan of bare ground until vegetation was encountered. The reason for the lack of vegetation and nesting near the pipe was not clear. In addition to the near-completion of the dredged material fill in the nesting area, another factor leading to the colonization at this site in 1977 was a de-watering of the site by drainage either in late 1976 or before 1977 nesting. Many of the marginal nests were in such wet areas that they were built to heights of 8 to 10 cm in

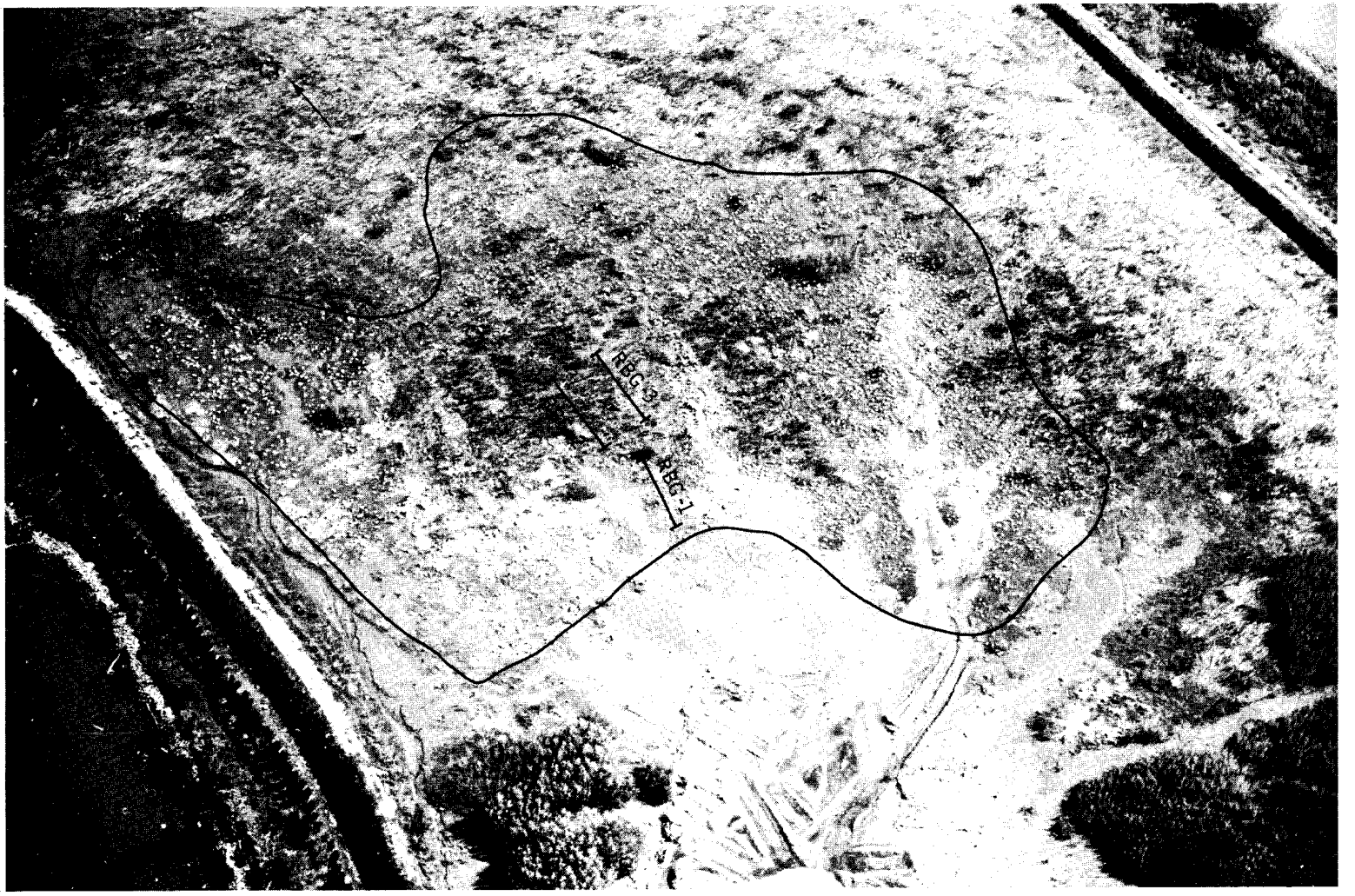


Figure 19. Grassy Island showing a ring-billed gull colony and vegetation sampling transects

order to keep the eggs dry. Typical of new, small, or marginal colonies, the nest density of this colony was low (0.15 to 0.22 nests per m^2), and certain groups of nests were retarded in their development. Common terns attempted to nest on the edge of the standing open water where filling had not yet occurred. These nests were unsuccessful probably because they were totally concealed by very dense cover of smartweed that grew up rapidly over the formerly bare muck.

Site 21. Toledo Harbor Dike

45. Location: 41°42' N., 083°26' W., a diked, dredged material disposal peninsula connected to the city of Toledo, Ohio (Figure 20a and 20b).

Species and Number of Nests:

	common terns:	1976-77 1977-263
	herring gulls:	1976-6 1977-13
	ring-billed gulls:	1976-none 1977-59
Colony Size:	common terns:	1976-0.14 ha 1977-0.34 ha
	herring gulls:	not aggregated
	ring-billed gulls:	1976-none 1977-0.12 ha

History: The rip-rapped dike was erected in 1975 and successful nesting of common terns and herring gulls occurred on the dike that season. In 1976, both species again nested successfully; but in 1977, ring-billed gulls began nesting and forced the terns to a portion of the dike where they were less productive than 1976.

Nesting Success: The common terns suffered about 95 percent mortality in the egg and chick stage in 1977, when they were found pierced but not eaten. The probable cause of this predation was black-crowned night herons which were seen frequently in the diked area. They were known to eat tern eggs and chicks. The only surviving common tern chicks were those sheltered by a dredging pipe. Nesting of ring-billed

Figure 20a. Toledo Harbor Dike showing colonies of common terns and ring-billed gulls and vegetation sampling transect

Figure 20b. Toledo Harbor Dike showing a common tern colony and vegetation sampling transect

gulls was very retarded and asynchronous in 1977 and their productivity was low.

46. Habitat: Different single plant species occurred in each of two transects in the ring-billed gull and common tern nesting areas, respectively. Common darnel, probably a survivor of the original seeding of the dike was found in the ring-billed gull nesting area. This area was used by the common terns in 1975 and 1976 with 20 common tern nests found on the edges of this site in 1977. Nest density of 0.22 nests per m^2 corroborated the recent development and marginally successful nature of this small ring-billed gull colony. The main nesting area of common terns nesting during 1977 was vegetated by smartweed which had less coverage (22 percent cover, Table 28) than the same vegetation that may have caused nest desertion at Site 19. The smartweed grew on freshly dredged material during the 1977 season, and it will probably provide more cover in later years unless fresh dredged material is placed over it.

Site 22. West Sister Island

47. Location: $41^{o}44'$ N., $083^{o}07'$ W., a natural island 15 km north of Port Clinton, Ohio (Figure 21).

Species and Number of Nests: great blue herons: 1600
great egrets: 200
black-crowned night herons: 300
herring gulls: 200
populations relatively stable 1976 and 1977.

Colony Size: (Equal to island size) 34.4 ha

History: Agriculture kept the island nearly free of woody vegetation during the early decades of the century. After farming ceased, the lighthouse keeper maintained domestic rabbits which kept the woody vegetation at an early successional stage. The rabbits declined when the lighthouse keeper left prior to World War II. Laurel Van Camp (1977, personal communication), during his first visit after the war, found great blue herons and great egrets nesting in trees.

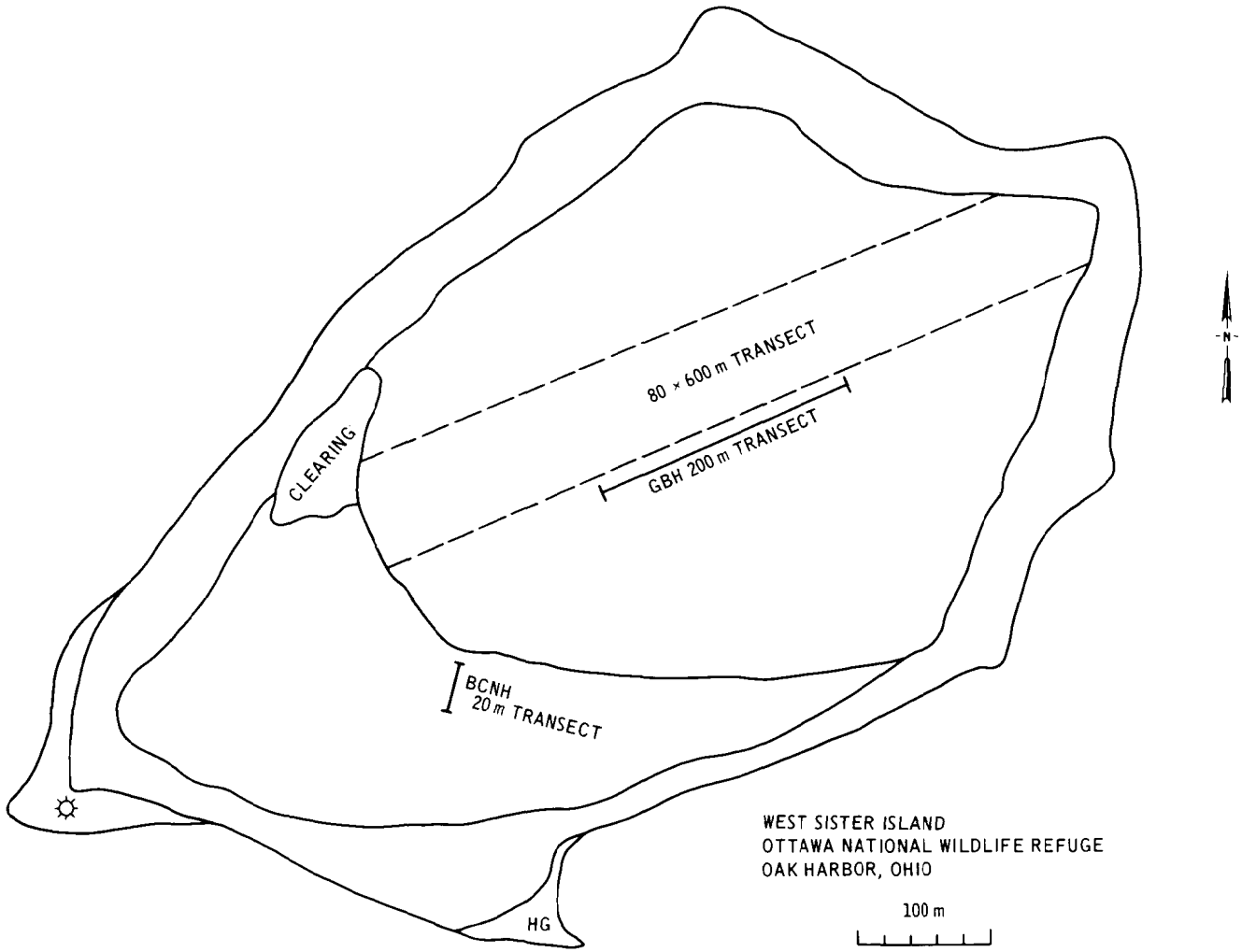


Figure 21. West Sister Island showing colonies of herring gulls, black-crowned night herons, great blue herons, and great egrets and population estimate transect and vegetation sampling transects

Since that time the vegetation has developed into a mature stage containing tall hackberry trees (Celtis occidentalis) with nesting of great blue herons and great egrets. The western portion of the island had young trees and brush with nesting black-crowned night herons. The island was a part of Ottawa National Wildlife Refuge and was classified as a Wilderness Area.

Nesting Success: Great blue herons and great egrets were successful in fledging many young each year, but some dead young were observed on the ground below the nests. Herring gulls often harrassed the fledglings learning to fly at the water's edge. It was unknown if any mortality resulted from this harassment, but this effect could be alleviated if more open fields were available for staging areas. The black-crowned night herons seemed to be successful with few dead present; and, as was typical of the species, many stages of nesting were evident in July. Herring gulls failed completely during 1976, and probably had very poor success in 1977 because of recreational boaters intruding on the nest site.

48. Habitat: Comparison of nest and non-nest trees of the single species stand of hackberry in which the great blue herons and great egrets nested surprisingly revealed a slightly greater importance value for the non-nest trees (Table 23). This is unusual for it would seem that the herons would nest in the largest trees. A few trees of other species were on the colony periphery, but no nesting occurred in them. The understory in this area showed wild rye (Elymus canadensis) to be most important followed by northern bedstraw (Galium boreale), spotted touch-me-not, and poison ivy (Rhus radicans). The smaller trees (less than 8 cm DBH) with the black-crowned night herons nests were entirely hackberry except for one small patch of plums (Prunus americana). The vegetation beneath the black crowned night herons has common chickweed (Stellaria media), wild rye, and catnip (Nepeta cataria) (Table 24). Trees in the black-crowned night heron area were increasing in size making it more suitable for the great blue heron and great egret nesting. Former open areas were being invaded by small trees suitable for the black-crowned night herons, but this eliminated important

Table 23

West Sister Island

Hackberry Trees Greater than 5 cm DBH in Great Blue Heron Nesting Area

HACKBERRY TREES (Celtis occidentalis)	RELATIVE DENSITY	RELATIVE DOMINANCE	RELATIVE FREQUENCY	IMPORTANCE VALUE
Ten 100 m^2 Quadrats				
Trees with Nests	40	45	50	135
Trees without Nests*	60	55	50	165

*Trees without nests less than 5 cm DBH averaged 1.03 trees/m^2.

Table 24

West Sister Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	GBH-1[1]	BCNH-1[2]
1 m^2 Quadrats*	(10)	(10)
Burdock	7	-
Wild rye	74	58
Northern bedstraw	68	-
Bottle-brush grass	-	69
Spotted touch-me-not	35	-
Catnip	17	67
Poke	13	-
Poison ivy	33	16
False Solomon's-seal	5	-
Bittersweet	7	-
Common chickweed	6	78
Common dandelion	8	-
Stinging nettle	29	12

*Sample sizes are indicated in parenthesis.

1. GBH = great blue heron.
2. BCNH = black-crowned night heron.

staging areas where young birds could begin to learn to fly without herring gull molestation. Ultimately, the black-crowned night herons will lose their habitat to normal plant succession. However, the recent death of some of the tall trees due to overfertilization may reverse this trend and provide new habitat for these herons. The herring gulls colonized a bare rock point on the southwest side of the island and also rocks around the periphery of the whole island.

Site 23. Sandusky Turning Point

49. Location: 41°27' N., 083°43' W., a rip-rapped, dredged material island, 0.5 km north of Sandusky, Ohio (Figure 22).

Species and Number of Nests: herring gulls: 1976-983
1977-878

Colony Size: 2.7 ha

History: The island was orginally constructed in 1900. Rip-rap was added in 1968. The history of the nesting herring gull colony was unknown.

Nesting Success: Although the island was easily accessible from city marinas and beaches, there was a high success rate and few dead chicks which indicated a high fledging rate.

50. Habitat: The vegetation was easily separated into two types: shrubs and herbs. Red mullberry (Morus rubra) and red-osier dogwood were the most important shrub species on the eastern portion of the island, and the red mulberry was mixed with small eastern cottonwoods on the western portion (Table 25). The shrub patches were very dense and precluded herring gull nesting in their centers, although their periphery was important as a nesting area and offered excellent visual isolation and territory separation. The growth of the shrubs would seem to make this site suitable to black-crowned night herons in the future, but the proximity to the urban area may prevent any colonization because they usually seek more secluded sites.

51. The herbaceous vegetation was diverse both within and between transects (HG-1 through HG-4, Table 25). On the eastern and middle portions of the island common winter-cress (Barbarea vulgaris)

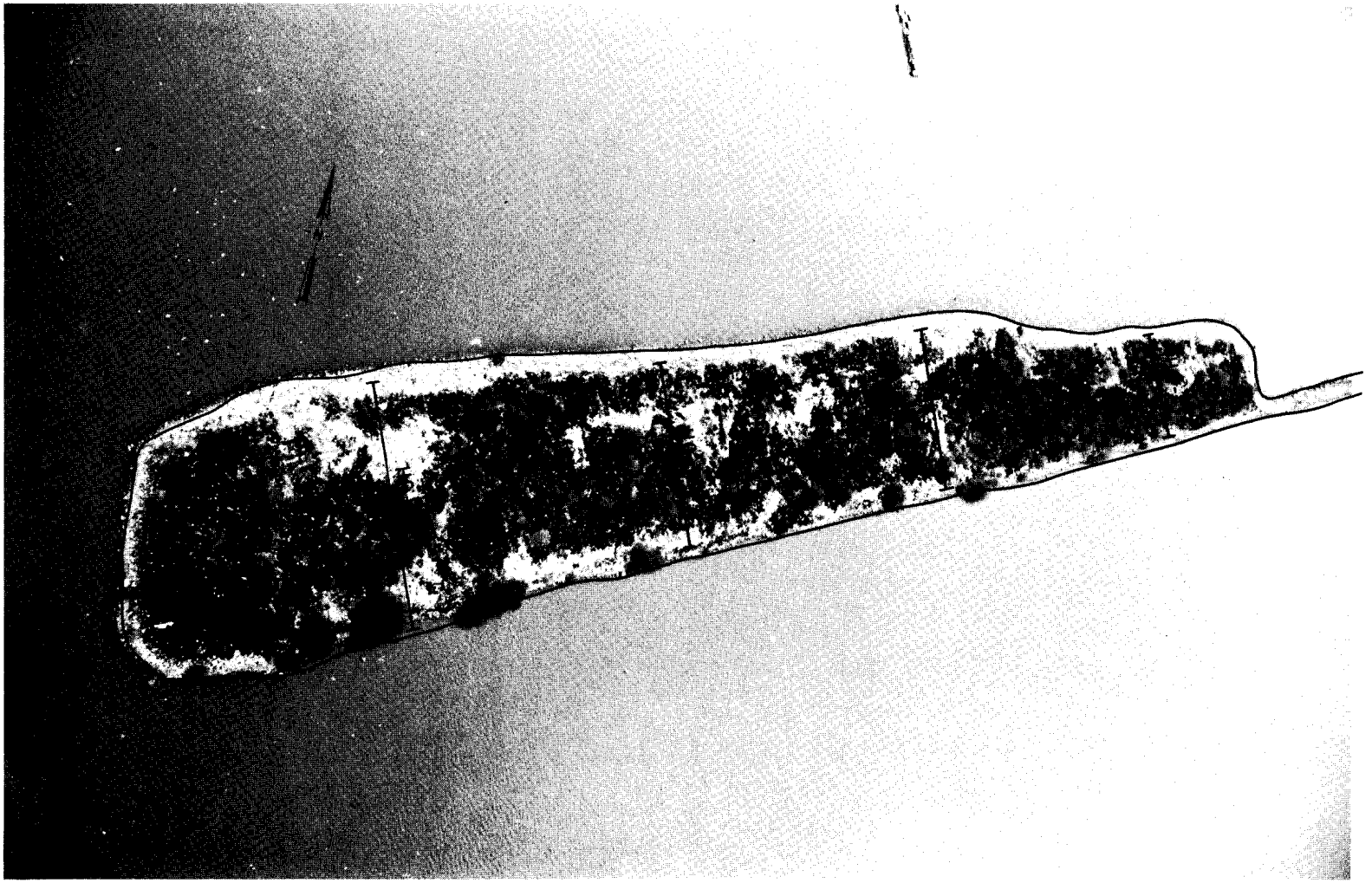


Figure 22. Sandusky Turning Point showing a herring gull colony and vegetation sampling transects

Table 25

Sandusky Turning Point

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	HG-1[1]	HG-2	HG-3	HG-4
16 m^2 Quadrats*	(1)	(2)	(4)	(1)
Red-osier dogwood	-	-	90	-
Red mulberry (Morus rubra)	300	300	210	170
Eastern cottonwood	-	-	-	130
1 m^2 Quadrats*	(16)	(13)	(10)	(20)
Box elder	6	-	-	-
Ragweed	-	-	9	-
Common burdock	14	4	14	39
Common milkweed	-	7	-	-
Aster (Aster sp.)	-	12	-	-
Common winter-cress	85	49	49	4
Brome-grass (Bromus japonicus)	5	-	-	-
Brome-grass	-	-	-	55
Musk thistle (Carduus nutans)	52	31	45	-
Pigweed	9	4	-	13
Common chickory (Chichorium intybus)	9	12	7	11
Canada thistle	-	-	-	14
Wild carrot (Daucus carota)	-	-	-	24
Morning glory	30	4	-	-
Lettuce	27	21	45	10
Butter and eggs (Linaria vulgaris)	-	-	-	11
Poor-man's pepper	-	-	-	10
White melilot	-	-	-	13

(Continued)

*Sample sizes are indicated in parenthesis.

1. HG = herring gull.

Table 25 (Concluded)

Sandusky Turning Point

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	HG-1[1]	HG-2	HG-3	HG-4
1 m^2 Quadrats*	(16)	(13)	(10)	(20)
Yellow melilot	-	-	-	4
Catnip	14	58	10	9
Parsnip	-	4	52	62
Goldenrod	37	90	20	-
Common dandelion	3	-	-	-
River-bank grape	5	-	55	22

*Sample sizes are indicated in parenthesis.

1. HG = herring gull.

and musk thistle, (Carduus nutans) comprised the most important vegetation, with varying mixes of goldenrod, parsnip (Pasitnaca sativa), lettuce, and other herb species. The percent cover of the herbaceous vegetation (49 percent, Table 29) revealed the large amount of rocky bare area present and was similar at two other herring gull sites already presented (Sites 11 and 15, 43 percent and 41 percent coverage respectively) which had a greater extent of bare area caused by the porous, sandy substrates in those areas. The relatively shallow slope of the rip-rap and lower elevation of this island allowed better survival of fledglings because they were less likely to fall off the island accidentally and could get back on easier.

Site 24. Little Galloo Island

52. Location: 43°53' N., 076°24' W., 5 km east of Stony Island, New York (Figures 23a and 23b).

Species and Number of Nests:

double-crested cormorants:	1976-76
	1977-96
black-crowned night herons:	1976-121
	1977-130
cattle egrets:	1976-none
	1977-2
herring gulls:	1976-200
	1977-200
ring-billed gulls:	1976-30,000
	1977-27,308

Colony Size: 10.5 ha

History: Double-crested cormorants, black-crowned night herons, and herring gulls nested here for at least the past decade, but no exact dates of colonization were known. Cattle egrets nested among the black-crowned night herons for the first time in 1977. The first documentation of ring-billed gulls nesting here was by Belnap (1961). Several employees at Stony Island recall common terns nesting on the island previous to the ring-billed gulls. Ludwig (1974) and personal communication) estimated 87,000 pairs of ring-billed gulls here in 1971 by what seemed to be reliable methods. If Ludwig (1974) was correct there has been a large population decrease of ring-billed gulls in recent

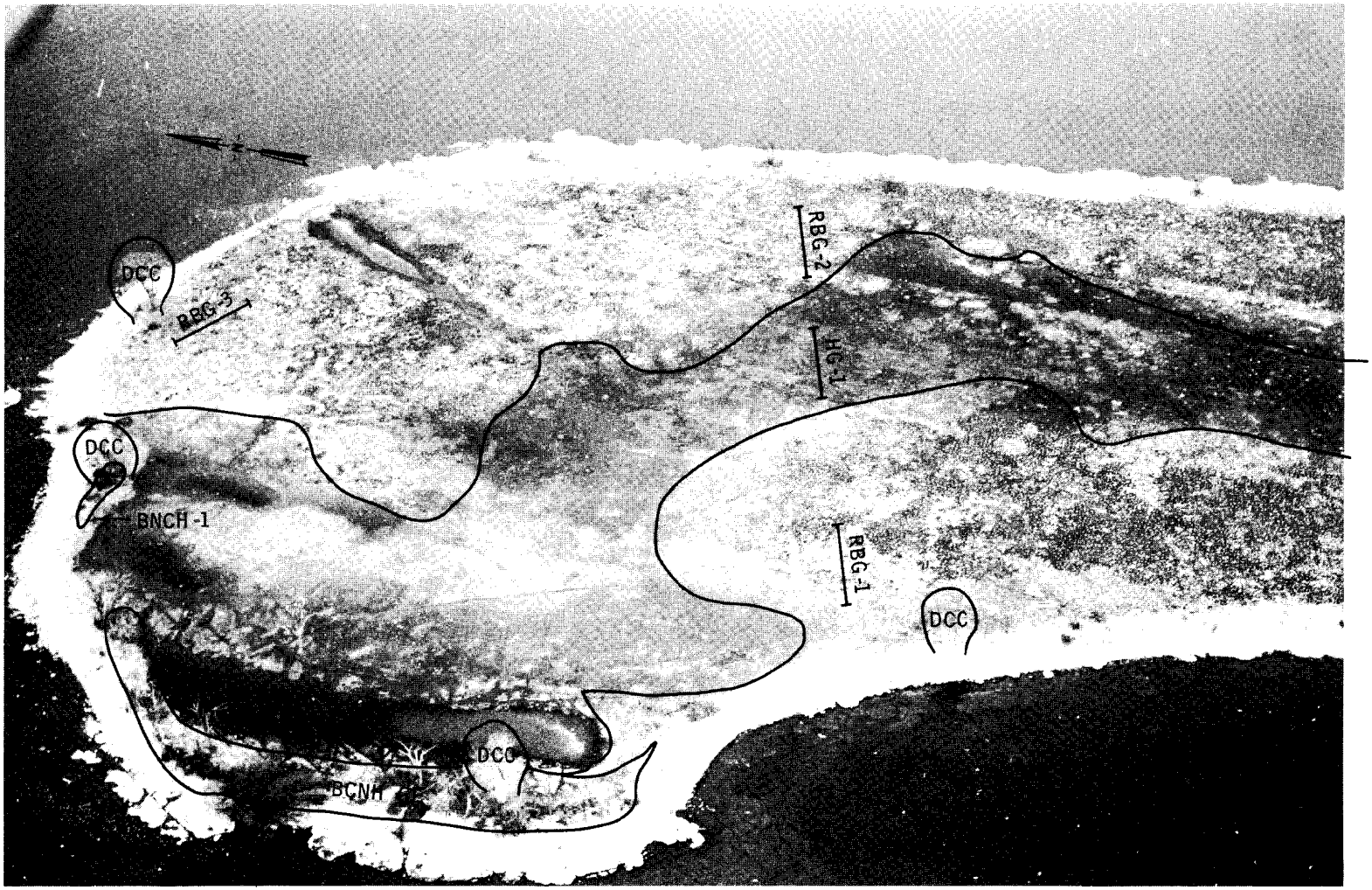


Figure 23a. The western end of Little Galloo Island showing colonies of double-crested cormorants, black-crowned night herons, cattle egrets, herring gulls, and ring-billed gulls and vegetation sampling transects

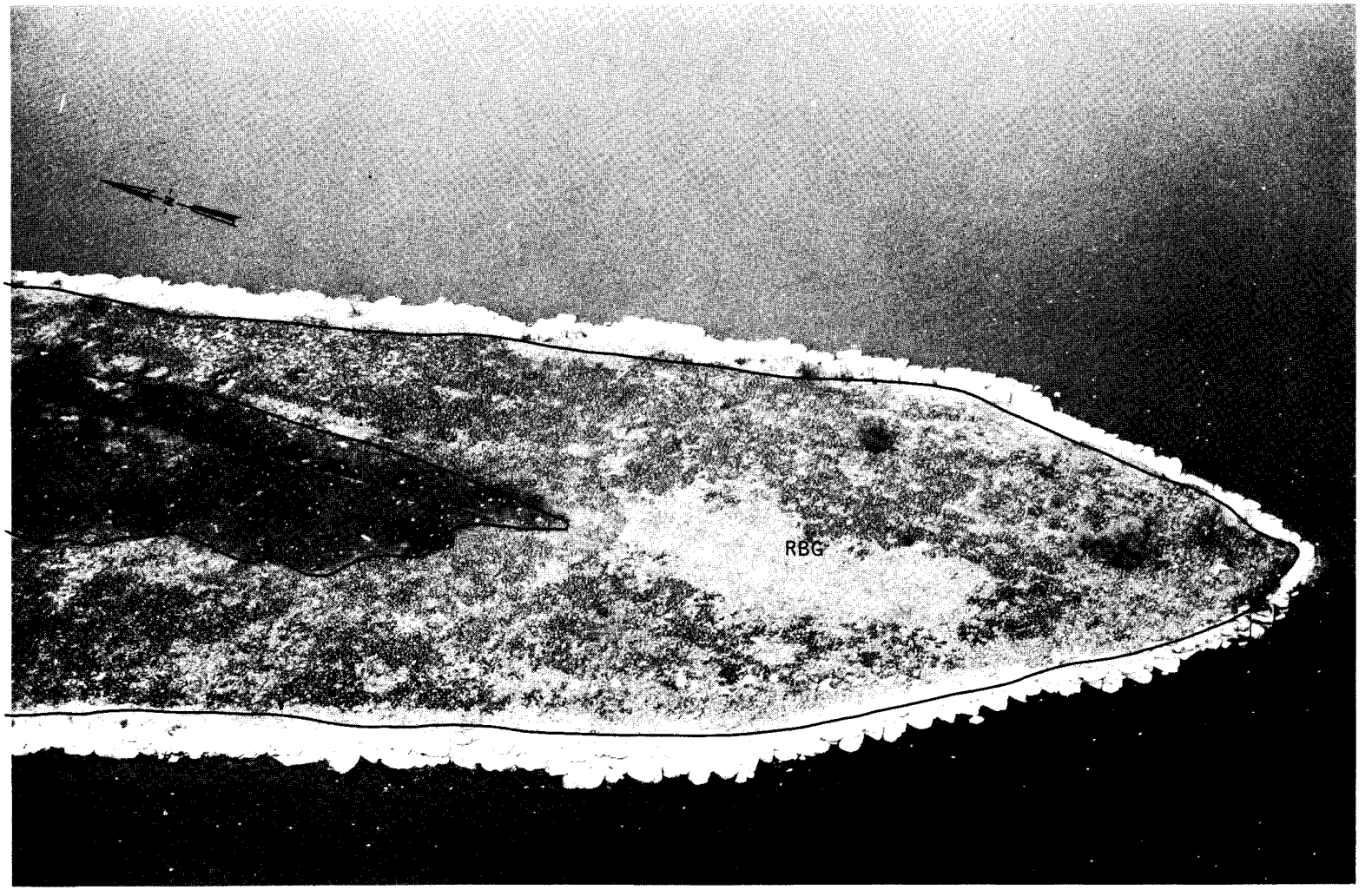


Figure 23b. The eastern end of Little Galloo Island showing colonies of herring gulls and ring-billed gulls

years. Also, in recent years, a Canada goose (Branta canadensis) herd of about 50 pairs has been nesting on the island, and has been encouraged by plantings made by the owners of the island.

Nesting Success: No unusual mortality was observed in any of the species and except for large water snakes (Natrix sipedon); no predators or human intrusions were noted. Therefore, nesting success was assumed to be high.

53. Habitat: The cormorants nested in several species of trees from 30 to 50 cm DBH along the periphery of the island. Black-crowned night herons nested in a mix of 1.5 to 2.0 m tall red-osier dogwood and red-berried elder with the dogwood being by far the most important (BCNH, Table 26) plants in the colony. The herring gull colony was surrounded by the ring-billed gull nesting area and coincided with the area plowed and seeded both about seven years ago for an emergency airplane runway and added goose habitat. The size of this area seemed to have increased somewhat in recent years, and may be due to the relative tolerance of the herring gulls and intolerance of ring-billed gulls to the increasing goose herd.

54. The ring-billed gulls were found nesting in predominantly herbaceous vegetation also with a high importance value for June grass (RBG-1 and 2, Table 26). The sampling bias toward the high number of stems of June grass obscures the visual impression that pigweed (in RBG-1, Table 26), ragweed, common winter-cress, stinging nettle, vetch (Vicia americana), (in RBG-2, Table 26) were also of major importance. Another contrast between the ring-billed gull and the herring gull habitats was the lesser percentage of vegetation cover in the ring-billed gull area (54 percent versus 87 percent, Tables 27 and 29). This again showed the effect the ring-billed gulls had on vegetation. The recent decline in ring-billed gulls at this site may have been due to four habitat factors; (a) loss of nesting habitat as a result of vegetation destruction by gulls, (b) flooding of nearly 1/8 of the island throughout 1976 with little subsequent nesting in this area in 1977, (c) the hypothesized antagonism of the increasing goose herd, and (d) overestimation of the nesting population by previous census takers.

Table 26

Little Galloo Island

Importance Values of Plants by Transect and Bird Species

PLANT SPECIES	BCNH[1]	HG-1[2]	RBG-1[3]	RBG-2	RGB-3
1 m^2 Quadrats*	(2)	(12)	(15)	(10)	(10)
Ragweed	-	-	15	50	-
Common winter-cress	-	32	-	73	-
Pickpocket	-	-	5	-	-
Pigweed	-	23	51	3	-
June grass	-	230	216	116	-
Stinging nettle	-	15	13	26	-
Vetch (Vicia americana)	-	-	-	32	-
16 m^2 Quadrats*					
Ragweed	-	-	-	-	15
Pigweed	-	-	-	-	26
Red-osier dogwood	255	-	-	-	-
Smartweed	-	-	-	-	16
Common elder	-	-	-	-	118
Red-berried elder	45	-	-	-	48
Bittersweet	-	-	-	-	18
Stinging nettle	-	-	-	-	59

*Sample sizes are indicated in parenthesis.

1. BCNH = black-crowned night heron.
2. HG = herring gull.
3. RBG = ring-billed gull.

Habitat Relationships

55. The seral stage present on the 24 intensively studied colony sites was indicated by determination of percent cover of the vegetation. Herb cover (Table 30) in a great blue heron colony and both herb and shrub cover in black-crowned night heron colonies always exceeded 50 percent, indicating the advanced seral stages preferred by those species. Common terns (Table 28) were at the other end of the seral spectrum with five of eight colonies having 22 percent to 43 percent cover. In one of the three colonies with higher percent cover (Site 3), the birds tended to move toward barer ground as it became available due to lowered water levels in 1977. The other two colonies (Sites 8 and 10) were unusually heavily vegetated for common terns, but probably showed much less vegetation early in the season when the terns begin nesting.

56. The percent cover of vegetation at sites colonized by ring-billed gulls (Table 27) showed nine of 16 sites with less than 50 percent herbaceous cover. Some of the higher values appeared to be biased by extensive aerial coverage of otherwise predominately bare ground or sampling bias which favored multi-stemmed grass species. In contrast, three herring gull colonies (Table 29) had less than 50 percent vegetation cover and two had cover of over 80 percent. These comparisons were in accord with the observations that ring-billed gulls were prone to damage vegetation with feet and feces, thus allowing only nitrophilous and guano-resistant species to grow in their colony sites on heavy soils and tending to kill most vegetation on sandy, porous soils. Both gull species were occasionally found nesting under shrubs and trees (16 m^2 Quadrats, Tables 27 and 29), but trends or preferences were not apparent, perhaps because these seemed to be marginal habitats. This is not to be interpreted that either gull was less successful in proximity to woody vegetation. Indeed, Chamberlin (1975) and Shugart (1976) have shown that woody vegetation could be important shade and hiding places for herring gull and ring-billed gull chicks, although it might not determine overall success.

Table 27

Percent Cover of Vegetation for Ring-billed Gulls by Location

		Duluth Port Authority	Minnesota Power and Light Co.	Moon Island	Southwest Neebish Island	Southeast Neebish Island	Lone Tree Island	South Manitou Island	High Island	West Grape Island	East Grape Island	Channel Island	Shelter Island	Mud Island	Grassy Island	Toledo Harbor Dike	Little Galloo Island	
Shrubs	RBG-1			16	8					37	33							
$16m^2$	RBG-2			45						62	50							
Quadrats	RBG-3									81						66		
	RBG-4									68*								
Average				30	8					60	42					66		
Herbs	RBG-1	62	36	22	29	70	44	37	27	0	0	72	55	77	50	40	52	
$1m^2$	RBG-2	75	43	19				3	34	4	14				85		56	
Quadrats	RBG-3		27					36		0					43			
	RBG-4		26							56*								
Average		69	33	21	29	70	44	25	30	1	7	72	55	77	59	40	54	

*Area adjacent to nesting colonies not included in tabulations.

Table 28

Percent Cover of Vegetation for Common Terns by Location

	Duluth Port Authority	Northwest Sugar Island	West Sugar Island II	West Sugar Island I	Southeast Neebish Island	Lone Tree Island	High Island	Toledo Harbor Dike	
Herbs $1m^2$ Quadrats	28	67	36	39	73	83	43	22	(Single transect at each site.)

Table 29

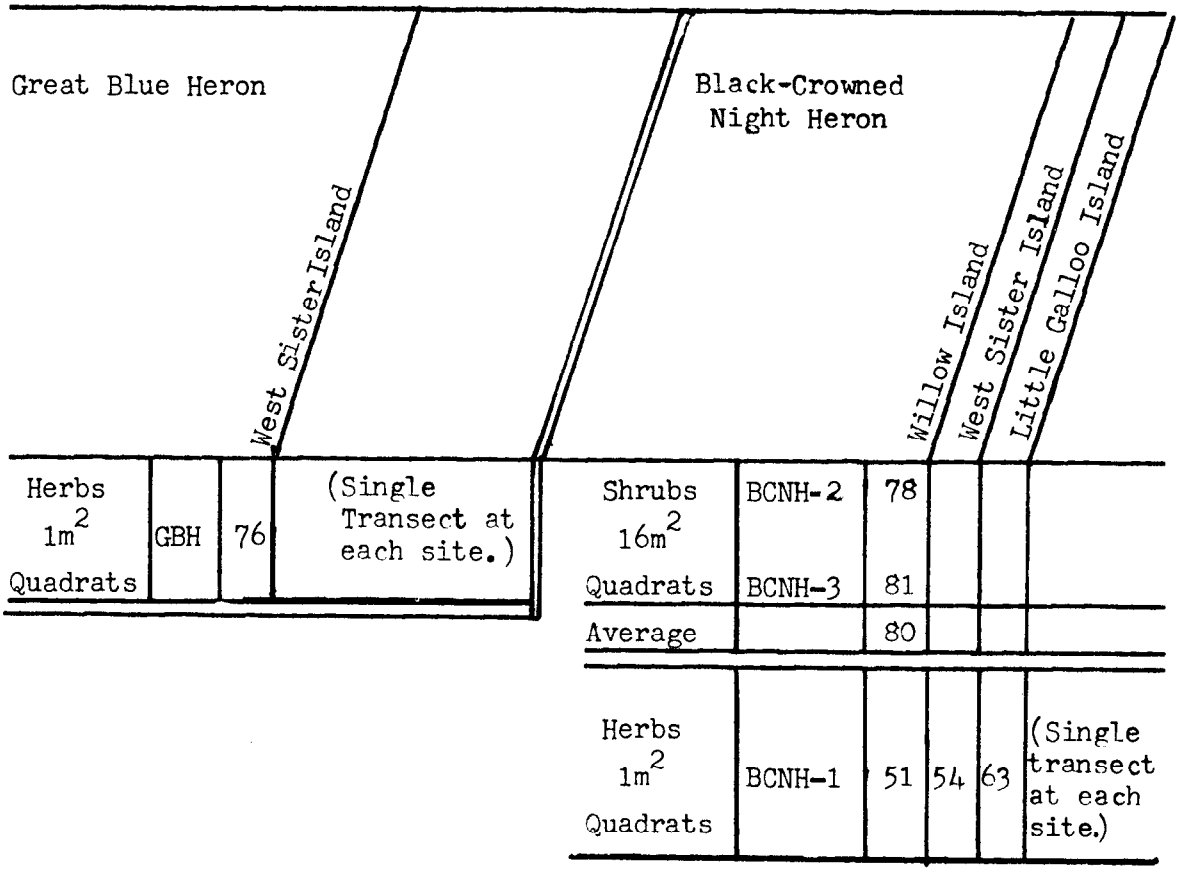
Percent Cover of Vegetation for Herring Gulls by Location

		South Manitou Island	Bellows Island	Hat Island	Sandusky Turn Point	Little Galloo Island
Shrubs $16m^2$ Quadrats	HG-1	30	4			
	HG-2	100	12			
	HG-3	0	67			
	HG-4	0	25			
Average		32	27			

		South Manitou Island	Bellows Island	Hat Island	Sandusky Turn Point	Little Galloo Island
Herbs $1m^2$ Quadrats	HG-1	36	95	48	37	87
	HG-2	50	96	29	52	
	HG-3		71	34	66	
	HG-4		67	36	43	
	HG-5			38		
	HG-6			44		
	HG-7			56		
Average		43	82	41	49	87

Table 30

Percent Cover of Vegetation for Bird Species by Location



57. The lowered water levels in 1977 allowed shifts in some island populations by exposing new surface on existing sites, and whole new sites that were previously submerged. Observers recorded an increase in several species in the lakes that coincided with the lowered water levels, although it was not known if this event had any role in the increase. An increase is probable in future nesting seasons as more pairs return to nest on greatly expanded habitat. The effects of receding water levels with the resultant increase in nesting area and accompanying plant succession on the size and movements of larid breeding populations have been discussed by Ludwig (1974). The total number of breeding pairs of herring gulls in 1977 was 29,406, and represented a 8.19 percent increase from 1976 (Table 31). Major herring gull increases occurred in the colonies in the St. Marys River; in Green Bay, Lake Michigan; in northern Lake Michigan; and in Thunder Bay, Lake Huron, but numbers elsewhere were less affected because of the nature of the rocky islands of Lakes Superior, Erie and Ontario that showed little effect of the lowered water. The size of many low-lying island nesting sites in Lake Michigan was doubled by receding water levels. Almost two-thirds of the 8.19 percent increase occurred on these low-lying Lake Michigan sites. Some of the herring gull colonies, such as the one on Bellows Island (Site 12), have not expanded to fill the newly exposed land fully. The possibility of other species such as ring-billed gulls or common terns filling these areas in the future is great. The ring-billed gull population included 102,539 pairs in 1977, an increase of 10.69 percent from 1976 (Table 31). This increase coincided with the lowered water levels and resultant increase in available nesting habitat. Ring-billed gulls often increased at the expense of another species. Ring-billed gulls and common terns had some habitat requirements in common, and so during competition for suitable habitat that was exposed at the larger sites in 1977 common terns were usually preempted by the more aggressive and earlier-nesting ring-billed gulls. The lowered water levels also created land bridges between many previous nesting sites and the mainland, thus exposing the tern colonies to increased human disturbances and predation. The 1977 common tern population consisted of 2,497 pairs, a

Table 31

Numbers of Breeding Pairs of U. S. Great Lakes Colonial Nesting Birds

By Species And Lake During 1976 And 1977

SPECIES	SUPERIOR		HURON[1]		MICHIGAN		ERIE[2]		ONTARIO[3]		TOTALS		PERCENT CHANGE[4]
	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	1976	1977	
HERRING GULL	5,634	6,619	9,141	9,276	10,347	11,978	1,347	1,210	250	323	26,719	29,406	+8.19%
RING-BILLED GULL	2,111	2,941	22,838	25,786	27,371	34,141	5,040	6,993	32,638	32,678	89,998	102,539	+10.69%
COMMON TERN	137	328	1,206	610	977	753	77	283	92	523	2,489	2,497	-18.80%
CASPIAN TERN	0	0	0	0	1,659	1,587	0	0	0	0	1,659	1,587	-4.34%
GREAT BLUE HERON	241	254	318	286	105	138	3,305	2,586	0	0	3,969	3,264	-17.76%
BLACK-CROWNED NIGHT HERON	0	0	67	166	519	558	3,000	3,000	121	130	3,707	3,854	+1.65%
DOUBLE-CRESTED CORMORANT	0	0	0	0	48	61	0	0	76	96	124	157	+26.61%
GREAT EGRET	0	0	0	0	0	0	231	224	0	0	231	224	-3.03%
SNOWY EGRET	0	0	0	0	2	0	0	0	0	0	2	0	-100.00%
CATTLE EGRET	0	0	0	0	13	29	0	0	0	2	13	31	+138.46%
LITTLE GULL	0	0	0	0	4	1	0	0	0	0	4	1	-75.00%
FORSTER'S TERN	0	0	0	0	298	54	0	0	0	0	298	54	-81.88%
TOTALS	8,123	10,142[5]	33,570	35,958	41,343	49,300	13,000	14,296	33,177	33,752	129,213	143,614	+10.03%

[1] Includes St. Marys River area.

[2] Includes Lake St. Clair and Detroit River Areas.

[3] Includes Niagara River area.

[4] Calculations excluded ten colonies of four species known to exist both seasons but for which an exact census was unavailable during one year.

[5] Reflects location of numerous herring gull colonies in 1977 at Isle Royale that are not shown in 1976.

decrease of 18.80 percent from 1976 (Table 31). Seven Caspian tern colonies existed during the 1977 season, all in northern Lake Michigan. The breeding population decreased 4.34 percent from 1,659 pairs in 1976 to 1,587 pairs in 1977 (Table 30). Both High Island Shoals and Shoe Island had been underwater during 1976 but were exposed in 1977. They were used for renesting attempts by terns that had been disturbed by human activities in the Hat and High Island colonies. These disturbances, plus coyote predation on High Island, accounted for the observed decrease.

58. Great egrets, great blue herons and black-crowned night herons showed little response to the lowered water levels, except at Oconto Marsh near Green Bay, Lake Michigan, where 300+ black-crowned night herons deserted a colony due to lack of standing water under the shrubs. Many of these birds were believed to have relocated at nearby Willow Island (Site 9). The 1977 great blue heron population was 3,264 pairs, and represented a 17.76 percent decrease from 1976 (Table 31). Almost all of the loss was from the Winous Point heronry in western Lake Erie and was due to an extensive blow-down of nest trees. The overall severity of this loss was tempered somewhat by indications that the herons renested at inland colonies outside the survey area proper. Great egrets were located at three nesting sites, all in the Lake St. Clair-Detroit River-Lake Erie area, and in association with nesting great blue herons. Their numbers (231 pairs, 1977; 224 pairs, 1977) remained essentially stable (Table 31). The black-crowned night heron population also remained stable, showing only a slight increase from 3,707 pairs in 1976 to 3,854 pairs in 1977 (Table 31).

59. The status of the double-crested cormorant in the Great Lakes appeared to be improving. The effect of the lower water levels in reducing the threat of washing away nests and killing nest trees as occurred during 1976 at the Gravelly Island and Cat Island Chain colonies, were reflected in the 26.61 percent increase in the breeding population from 124 pairs in 1976 to 157 pairs in 1977 (Table 31). Two pairs of snowy egrets were found nesting on flooded willows within the Oconto Marsh black-crowned night heron colony in the Green Bay region of Lake

Michigan in 1976 (Table 31). In 1977 the water under the willows dried up and the snowy egrets deserted the site, as did 300+ of the night herons. Although cattle egrets also nested in Oconto Marsh in 1976, they did not desert their nests in 1977. In fact, the number of cattle egrets in the Green Bay area increased 138.46 percent from 13 pairs in 1976 to 31 pairs in 1977 (Table 31). The little gull and Forster's tern also nested in Green Bay marshes during 1976. However, the drying up of their marsh habitats in 1977 resulted in the absence of any nesting little gulls, and in a reduction in Forster's terns from 298 pairs in 1976 to only 54 pairs in 1977 (Table 31). A census of northern green herons and black terns was made only in the Green Bay region of the survey area, although nesting black terns were observed in all five Great Lakes and the herons in all but Lake Superior. However, the situation that was documented in Green Bay appeared representative throughout the Great Lakes: dried up marshes due to lower water levels, reduced nesting habitat, reduced breeding populations of both species. Further evaluation of both historical and recent population trends for the above species was given in Scharf et al. in press.

Soil Analyses

60. Table 32 summarizes pH, soil texture, and the nutrients, total nitrogen, phosphorus, and potassium for most of the 24 intensively studied sites in addition to Ile aux Galets and Gravelly Island in northern Lake Michigan. Generally, these results showed massive amounts of soil nutrients. In the heavily fertilized colonies, pH typically ranged from slightly below neutral to alkaline (exceptions seemed to correlate with highly organic textures). It is hypothesized that levels of soluble salts increased to phytotoxic levels, as noted by Wiese (1977), and McColl and Burger (1976), although the levels of specific nutrients are not directly comparable. The former study was in marsh and aquatic habitats and the latter was conducted on sandy soils and did not report total nitrogen.

61. Precise levels of phytotoxicity varied with texture, pH, and a variety of other factors and published values were few or non-

Table 32

Summary of pH, Texture, and Soil Nutrients in ppm, by Location and Bird Species

GREAT BLUE HERON	pH	NITROGEN	PHOSPHOROUS	POTASSIUM	SOIL TEXTURE
West Sister Island	7.0	17400	458	388	Organic
BLACK-CROWNED NIGHT HERON					
*Willow Island	7.6	7700	294	415	Organic
West Sister Island	6.2	11230	352	748	Organic
West Sister Island	6.4	8970	144	288	Organic
HERRING GULL					
*Willow Island	8.1	100	16	14	Sand soils
Bellows Island	6.8	18000	1138	297	Organic
Bellows Island	4.7	10400	144	212	Organic
*Sandusky Turning Point	6.8	5420	94	114	Organic
RING-BILLED GULL					
*Duluth Port Authority	6.6	1300	384	467	Sandy Loam
*Minnesota Power and Light Company	7.3	10200	554	458	Organic
*Moon Island	7.0	24800	1510	660	Organic
*Southwest Neebish Island	6.6	32000	1700	440	Organic
Southeast Neebish Island	7.6	1400	141	177	Sandy Clay Loam

(Continued)

*Man-made sites.

Table 32 (Continued)

RING-BILLED GULL (continued)	pH	NITROGEN	PHOSPHOROUS	POTASSIUM	SOIL TEXTURE
*Lone Tree Island	7.2	8300	652	588	Organic
South Manitou Island	7.1	3370	352	206	Sand Soils
High Island	6.8	600	1289	93	Loamy Sands
West Grape Island	4.2	30800	554	343	Organic
*Channel Island	7.5	23000	1996	917	Sandy Clay Loam
*Shelter Island	7.6	7400	1112	396	Sandy Clay Loam
*Mud Island	7.3	32700	1343	572	Organic
*Mud Island	6.9	10570	560	360	Organic
*Grassy Island	7.3	3000	407	440	Sandy Clay Loam
*Toledo Harbor Dike	7.5	4000	39	480	Sandy Clay Loam
Little Galloo Island	5.0	25900	1407	308	Organic
Ile aux Galet	6.3	25900	1621	510	Organic
COMMON TERN					
*Duluth Port Authority	7.7	400	21	40	Sandy Loam

(Continued)

*Man-made sites.

Table 32 (Concluded)

COMMON TERN (continued)	pH	NITROGEN	PHOSPHOROUS	POTASSIUM	SOIL TESTURE
*Northwest Sugar Island	7.3	3030	127	928	Sandy Clay Loam
*West Sugar Island I	7.3	200	144	67	Sand Soil
*Lone Tree Island	7.5	1600	117	139	Loamy Sand
CASPIAN TERN					
High Island	7.7	500	503	209	Loamy Sand
Hat Island	7.3	3680	640	330	Sand Soils
Gravelly Island	7.4	76300	7071	1861	Organic

*Man-made sites.

existent. However, where certain plant species seemed to thrive in the presence of extremely high nutrients to the exclusion of other plant species, it was concluded that they were tolerant or resistant to the chemical onslaught of bird feces. Such plants were most apparent at ring-billed gull colony sites with heavier soils of organic to sandy-clay-loam textures (Table 32). A brief list of species resistant to excess nutrients found in ring-billed gull colonies would include: pigweed, yellow melilot, reed, choke cherry (Prunus virginiana), stinging nettle, and various Cruciferae species listed in the importance values of each site. Low grasses such as witch-grass, brome-grass, and June grass also seem resistant to overfertilization, but are usually eliminated before the herbs of the first list. On coarse sands such as South Manitou Island (Site 11), the most resistant species persisted longest, but finally almost all the plants were eliminated by over-fertilization, forcing the birds to move to more vegetated areas.

62. There was clearly a difference in the soil textures and nutrients of larid colonies (Table 32). Common tern and Caspian tern colonies had lower levels of nutrients present on coarser soils. The one exception was Caspian terns (Gravelly Island) in which an organic layer of fish castings overlying a sterile cobble surface was present. Ring-billed gulls seemed to be most successful on the heavier textured, nutrient rich soil types, but none of the organic textured soils showed the levels of nutrients above 20,000 ppm that were found at ring-billed gull sites. It should be noted that all four larid species also nested on bare rock in the U. S. Great Lakes.

63. A contrast between the nutrient input of common terns and ring-billed gulls at Duluth Port Authority (Site 1) was evident in Table 32. The whole colonized area was bare sandy loam in 1976, and common terns were present both in 1976 and 1977. However, in the first year of occupancy, the nutrient values in the ring-billed gull colony varied from three to 15 times that of the common tern area. This new ring-billed gull colony was lower in nutrients in comparison to other established ring-billed gull colonies, and the values were comparable to other first year colonies at Grassy Island (Site 20) and Toledo Harbor

Dike (Site 21).

64. The great blue heron and black-crowned night heron sites sampled show more moderate enrichment than the gull sites, but the values (Table 32) were probably still phytotoxic to many species of plants. Some of the woody species in which the herons nested showed signs of stress from the over-fertilization at all sites. These trees and shrubs, once weakened, were often killed, abandoned, or blown down by winds. The soil textures at the heron sites sampled were all organic, indicating the more advanced seral stages occupied by these birds.

Chronology of Nesting

65. The breeding season could be thought of as a sequence of stages that build on the preceding events and each gradually changes to the next. The successive stages (Figure 24) could be briefly described as courtship, egg laying, incubation, hatching, chick brooding at the nest and chick care away from the nest. Initially, control of the sequence was endogenous control which was externally triggered by factors such as light and temperature. As the sequence progressed, external stimulation from eggs and chicks maintained hormonal systems and behavioral responses.

66. Breaks in the sequence of events usually recycled the pattern starting approximately one to two weeks prior to egg laying. The chronology shown in Figure 24 only reflects initial nesting attempts and has been made sufficiently broad for predictive purposes to encompass the differences in light and temperature experienced within the 700 km latitudinal distance of the U. S. Great Lakes. Additional factors affecting the chronology of colonial nesters in this region are ice conditions, and the migration routes and dates of arrival at the site. Some sites in Canadian Lake Ontario have birds in nearly continuous residence (Peter M. Fetterolf, 1977, personal communication).

67. Another factor determining the chronology of the breeding season was the age and experience of returning pairs. Experienced pairs need not go through the process of establishing a pair bond, but need

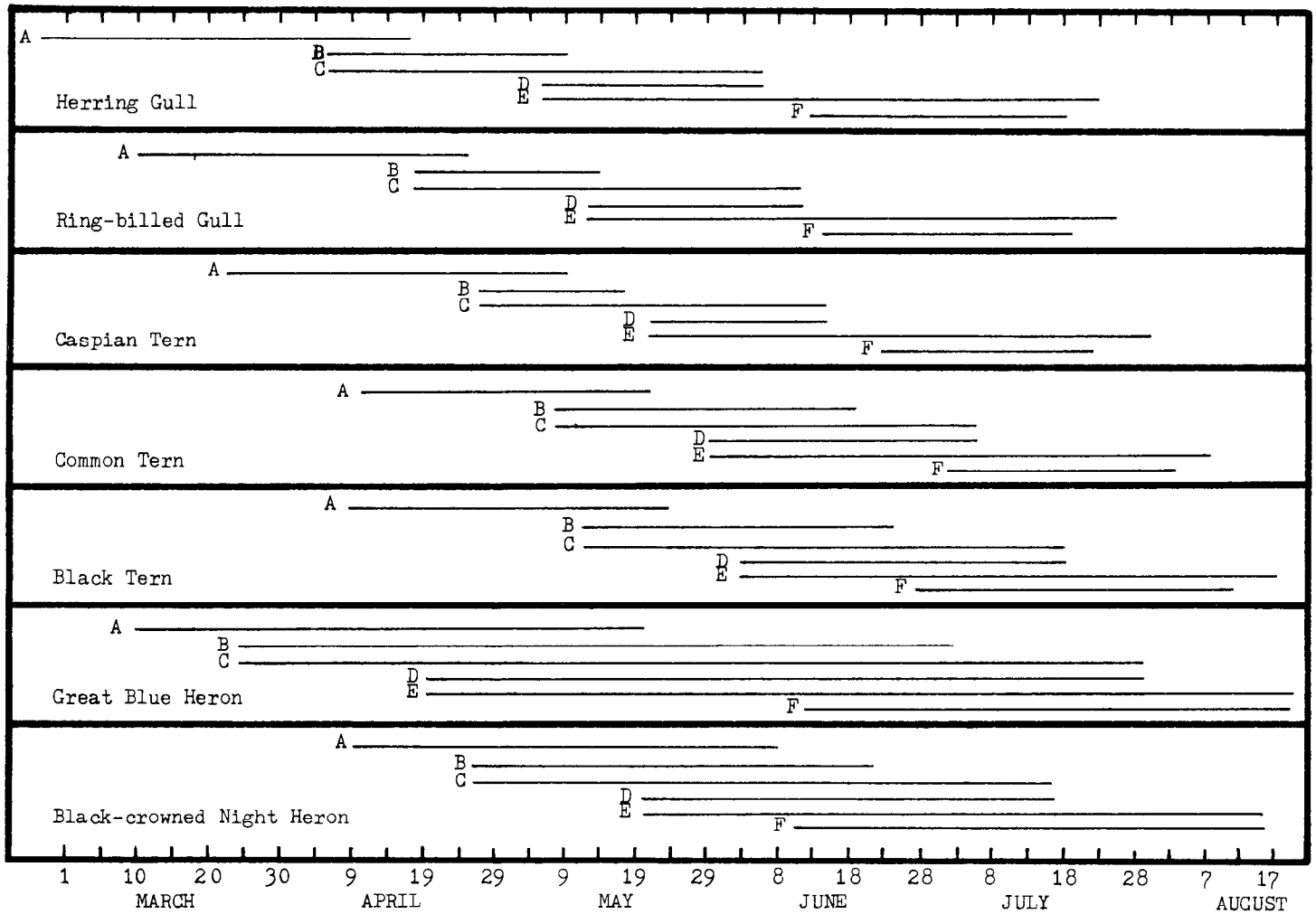


Figure 24. Chronology of initial nesting for major colonial nesting bird species of the U. S. Great Lakes. Within each period (i.e. A,B,C,D,E,F), birds nesting at southern most latitudes will begin nesting earlier than birds of the same species in the north. Period A = courtship; period B = laying; period C = incubation; period D = hatching; period E = chick care at the colony; period F = fledging

only renew it, and probably lay eggs one to two weeks before newly established pairs. This was shown in 1977 when large established colonies of ring-billed gulls, which probably have a high proportion of returning pairs, showed earlier peak hatching dates regardless of latitude than did new colonies, large or small (Figure 25). The new colonies also showed wider nest spacing, excessive mortality, and less synchrony of hatching. This could have been because new colonies were selected at the time of first breeding and few experienced birds move to new sites. Parson (1976a and 1976b) and Davies (1976) showed that younger herring gulls nested at lower densities and had less success than older, more experienced birds.

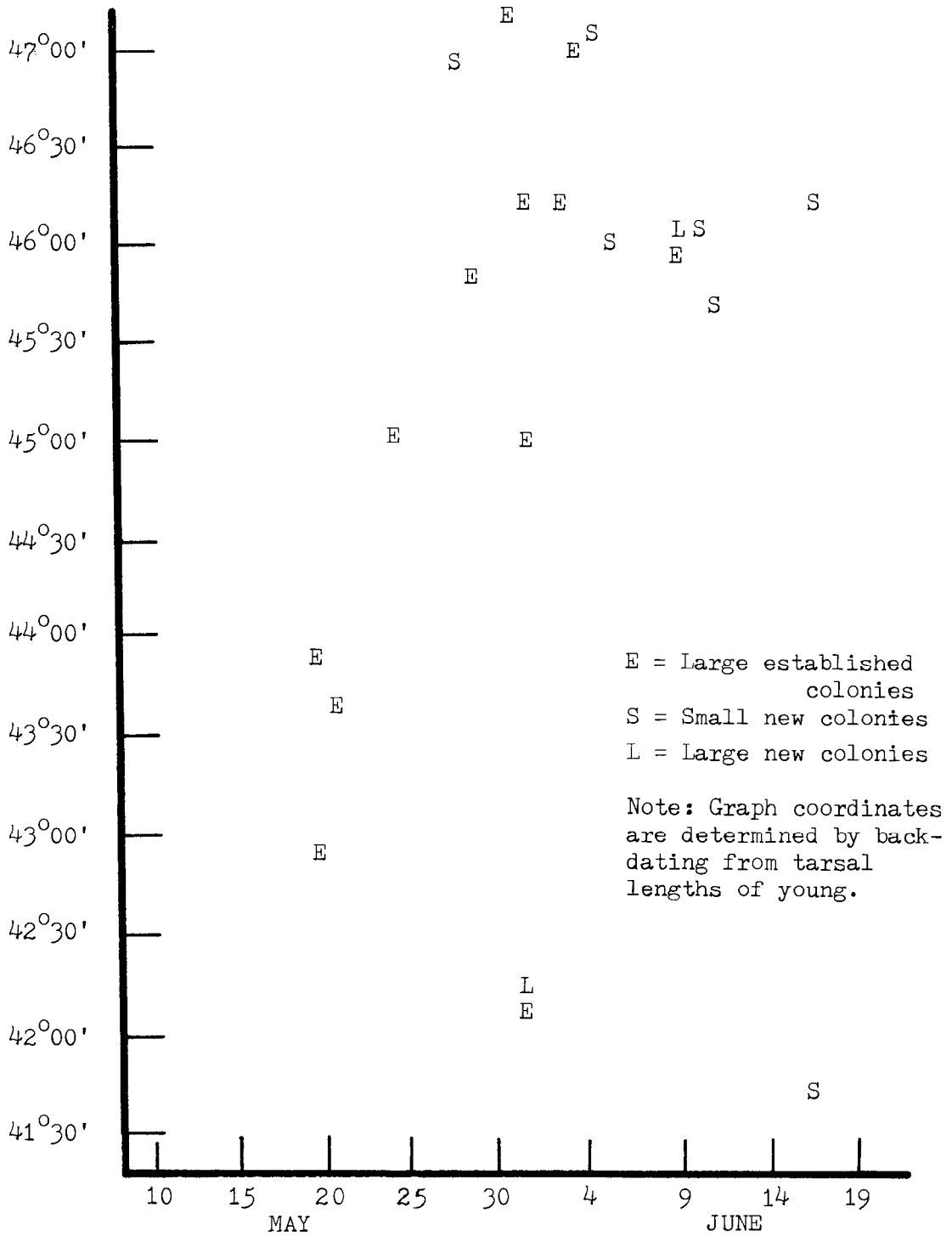


Figure 25. Peak hatching dates of ring-billed gulls in relation to latitude

PART IV: DISCUSSION

Plant Succession

68. The rate of plant succession on Great Lakes colonial bird nesting sites, both natural and dredged material, appeared to be slower than that reported for dredged material sites in North Carolina (Soots and Parnell, 1975). Dredged material islands 20 to 40 years after construction were just beginning to show growth of shrubs and saplings. Occupancy by ring-billed gulls would retard succession indefinitely, depending on the nature of the soil. Heavier soils (with higher clay and organic matter content) seemed to be able to support plants resistant to over-fertilization, and the sites will re-vegetate each season to remain suitable for ring-billed gulls. Lighter, sandier soils experienced more severe plant mortality due to trampling and over-fertilization from ring-billed gulls resulting in movement of nesting sites in subsequent seasons. Ludwig (1962) stated that red-osier dogwood and willow grew in newly exposed sites in five to six years and crowded ring-billed gulls seeking nesting sites. In this study no evidence for this trend was observed. In fact, ring-billed gulls frequently severely damaged or killed most woody vegetation, and at several sites willows formed important visual barriers that promoted high nest density.

69. The rate of plant succession on both dredged material and natural sites was greatly influenced by the groundwater table which determined whether the sere was hydric or xeric. In 1977, lowered water levels in the Great Lakes caused formerly wet areas to become dry, and plant composition was greatly altered. Some dredged material islands remained with standing water for many years which prevented colonial bird nesting. A modified dewatering procedure at Grassy Island, a diked dredged material island in the Detroit River, lowered standing water enough to allow ring-billed gull and common tern nesting for the first time in 1977. Draining, damming or timing of deposition are management techniques that could be planned to attract colonial nesting birds, depending on the species desired. Addition of new dredged material could also be managed to control plant succession, and thereby control the

colonial nesting birds.

70. Only three dredged material sites had progressed to the shrub sere suitable for black-crowned night herons, and none had trees which might be inhabited by great blue herons or great egrets. Two of the black-crowned night heron dredged material sites will be destroyed by a newly planned diked disposal site in 1978-1979. Several natural sites historically occupied by great blue herons (Scharf et al. in press) lost their trees through cutting or bird-accelerated mortality and did not regain their woody vegetation. These sites in 1977 had nesting gulls and show little sign of developing woody plants. Other natural sites such as West Sister Island in Lake Erie had some trees being killed by the great blue herons and great egrets, while the shrubs bearing nests of black-crowned night herons were becoming trees suitable for the larger herons. Clearly at a site such as this, management by cutting or burning would be needed to maintain high levels of nesting by both species. At this site, the openings that served as staging areas for young after they leave the nest had become overgrown with shrubs, and succession needed to be reversed in this sere.

Management Recommendations for Dredged Material Sites

71. All dredged material sites with suitable habitat and appropriate isolation from human and predatory disturbance had bird nesting colonies in 1976-1977 suggesting that if more suitable sites are constructed, they also would probably be colonized. Human disturbance and access by predators could and should be discouraged through posting against trespass and placement of islands at isolated locations if bird nesting is to be encouraged. The regulation requiring the U. S. Army Corps of Engineers to give up dredged material sites after use as a disposal site has resulted in a decision by Detroit District to deed large diked disposal areas to units of government for recreation purposes. This will cause conflicts between public and bird usage.

72. The recent practice of diked disposal of dredged material had several effects on nesting or potential nesting. One effect was that high rip-rapped dikes sometimes caused mortality to young that fell down

the steep slopes and could not regain access to the colony. Another effect was that the diked areas were frequently large and filled by sections. This allowed different stages of substrate and vegetation development which might be more or less suitable to colonial nesting birds. More specifically, at one site de-watering of recent dredged material allowed colonial nesting there, but in another part of the same site treated differently the vegetation had succeeded beyond desired stage for nesting. The area was essentially a marsh growing on the dredged material. Another effect of diked disposal practices was that nesting on the dike prior to filling frequently was attractive to the birds and the filling and construction efforts were possibly disruptive to nesting success.

73. Dredged material varied greatly in its particle size and potential for soil and vegetation establishment. This factor could determine the rate of vegetation succession and hence the avian species using a site. Common terns and Caspian terns respond to bare sterile sites, and great blue herons, great egrets, and black-crowned night herons occupy tree and shrub stages. Recommendations set forth by this study are to maintain both bare habitats and encourage wooded habitats. Plantings can augment this procedure by which grasses are planted on bare sites, rather than trees as was done by private citizens on one site studied.

74. Finally, the construction of dredged material sites of heavy soil materials are most likely to lead to more ring-billed gull nesting. Ring-billed gulls increased recently in the Great Lakes (Scharf et al., in press and Ludwig, 1974), and concern was expressed about possible aircraft hazards and their displacement of common terns (Morris and Hunter, 1976). Coverings of porous-sandy materials or rock might encourage common tern or herring gull nesting. This would aid their population stability and prevent further expansion of ring-billed gulls. Management has been attempted recently in Canada (Blokpoel, 1977, personal communication) where ring-billed gull nests were destroyed in a mixed colony with common terns in order to aid the terns.

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APPENDIX A:

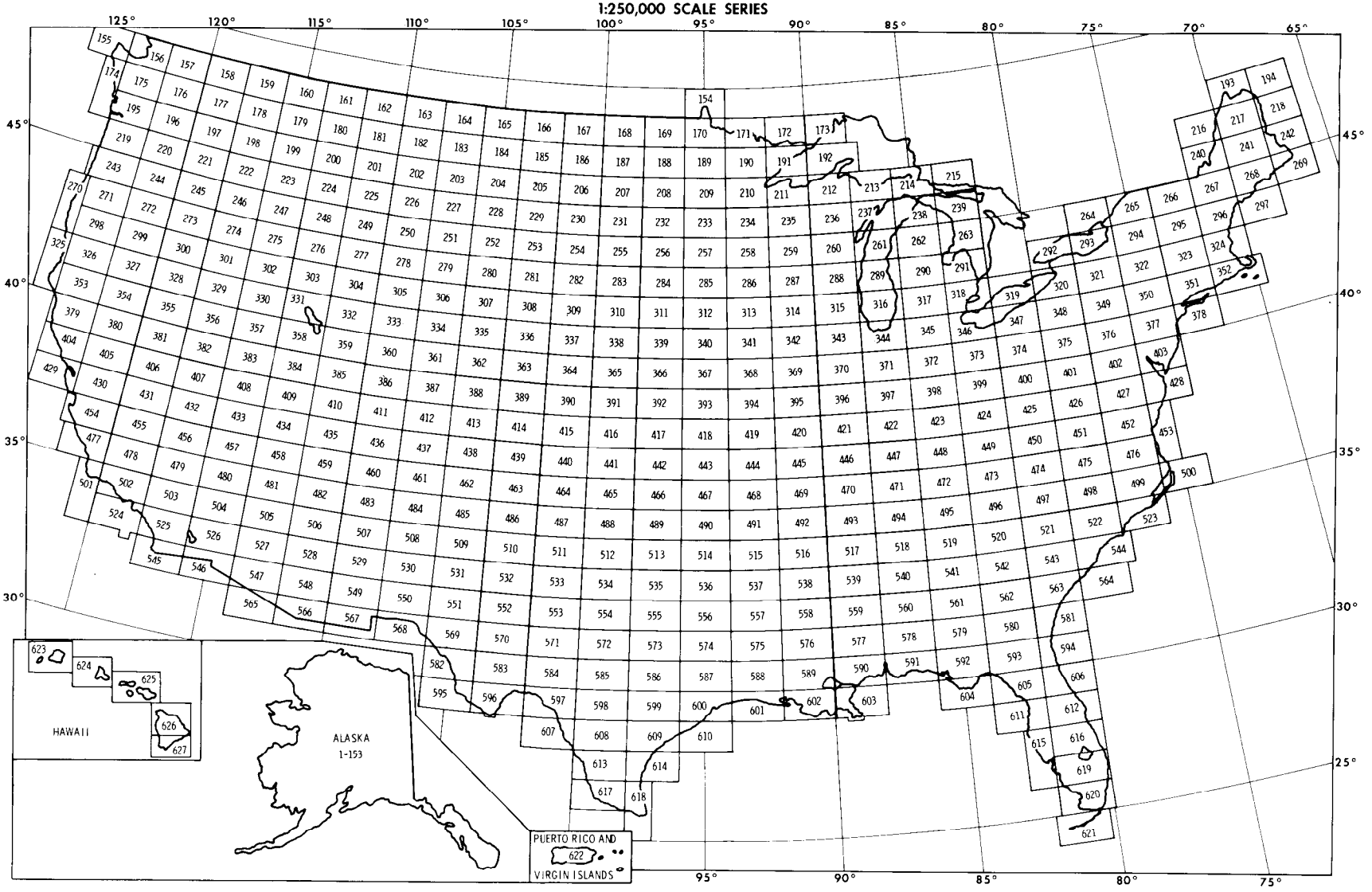
MAPS SHOWING COLONY LOCATIONS

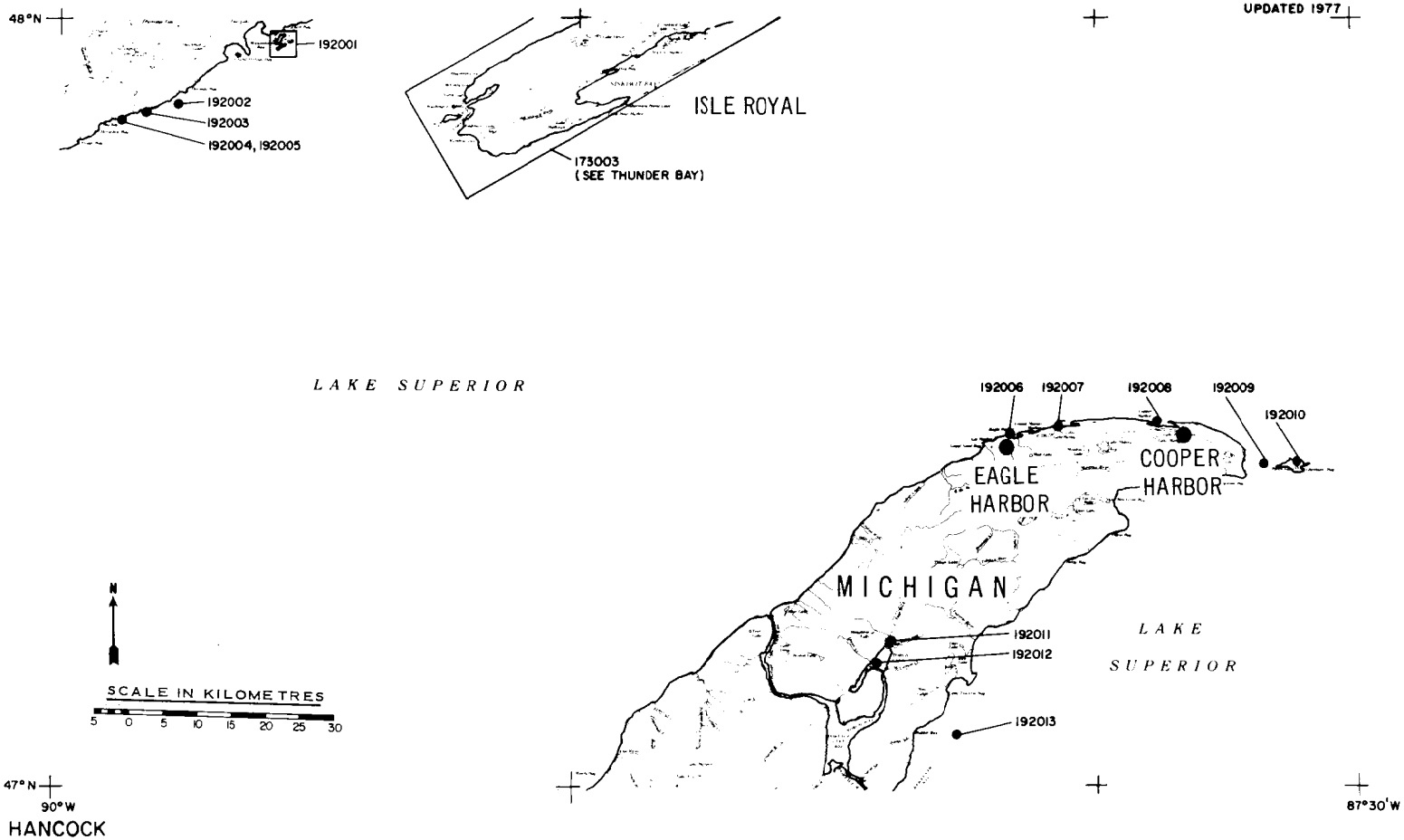
1. Colony location identification was based on the U. S. Fish and Wildlife Service computerized mapping system, which assigned digits to USGS 1:250,000-scale topographic maps. An index map designating the key for the first three digits is presented on page A2.

2. Colony identification was by a six-digit number. The first three digits indicated the assigned topographic map, and the last three digits indicated the colony number on a specific map. The colonies were numbered in the chronological order in which they were located.

INDEX TO COASTAL ECOSYSTEM BIRD COLONY MAPS

1:250,000 SCALE SERIES

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192002
192003
192004, 192005
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173003
(SEE THUNDER BAY)
UPDATED 1977
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192006
192007
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192009
192010
EAGLE HARBOR
COOPER HARBOR
MICHIGAN
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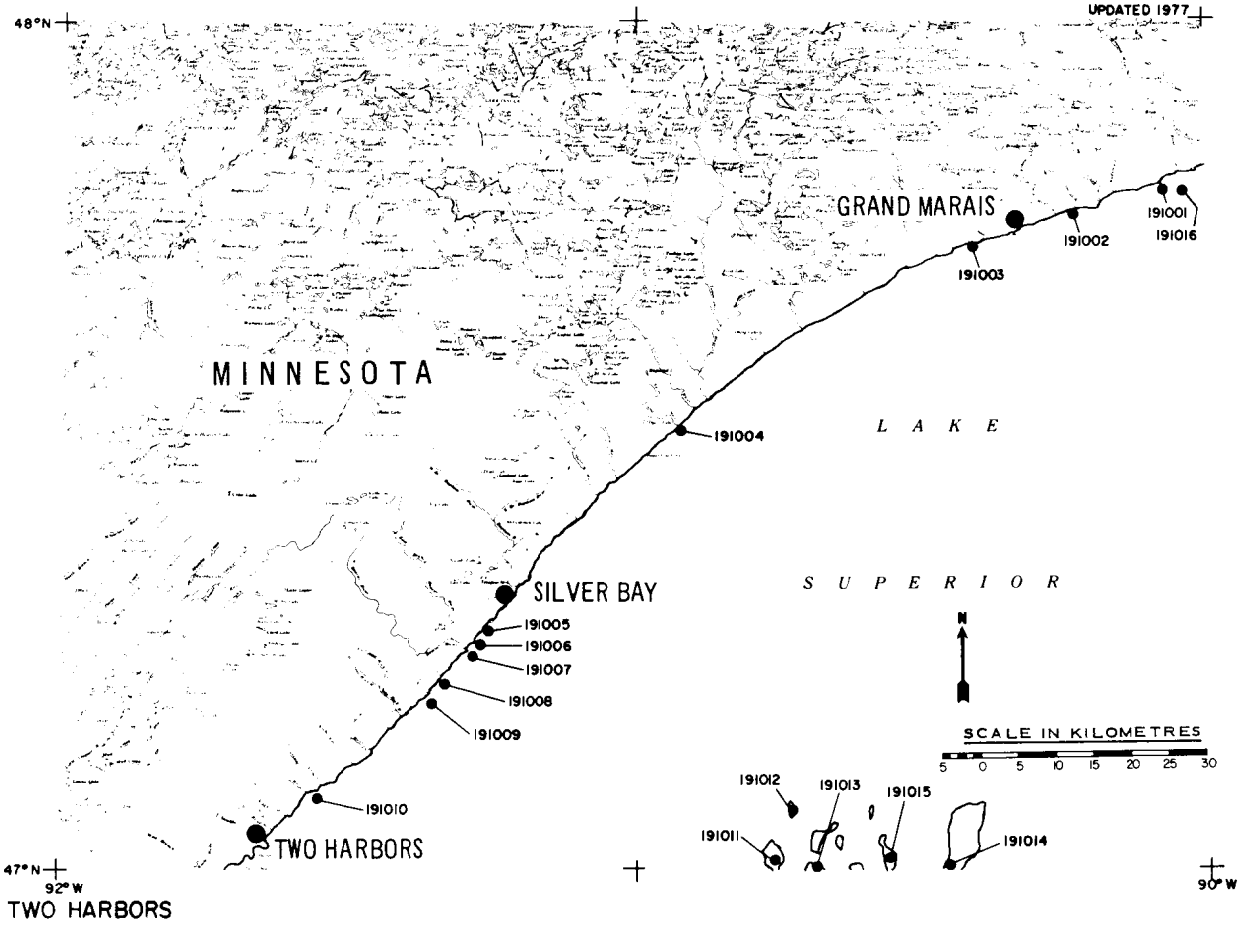
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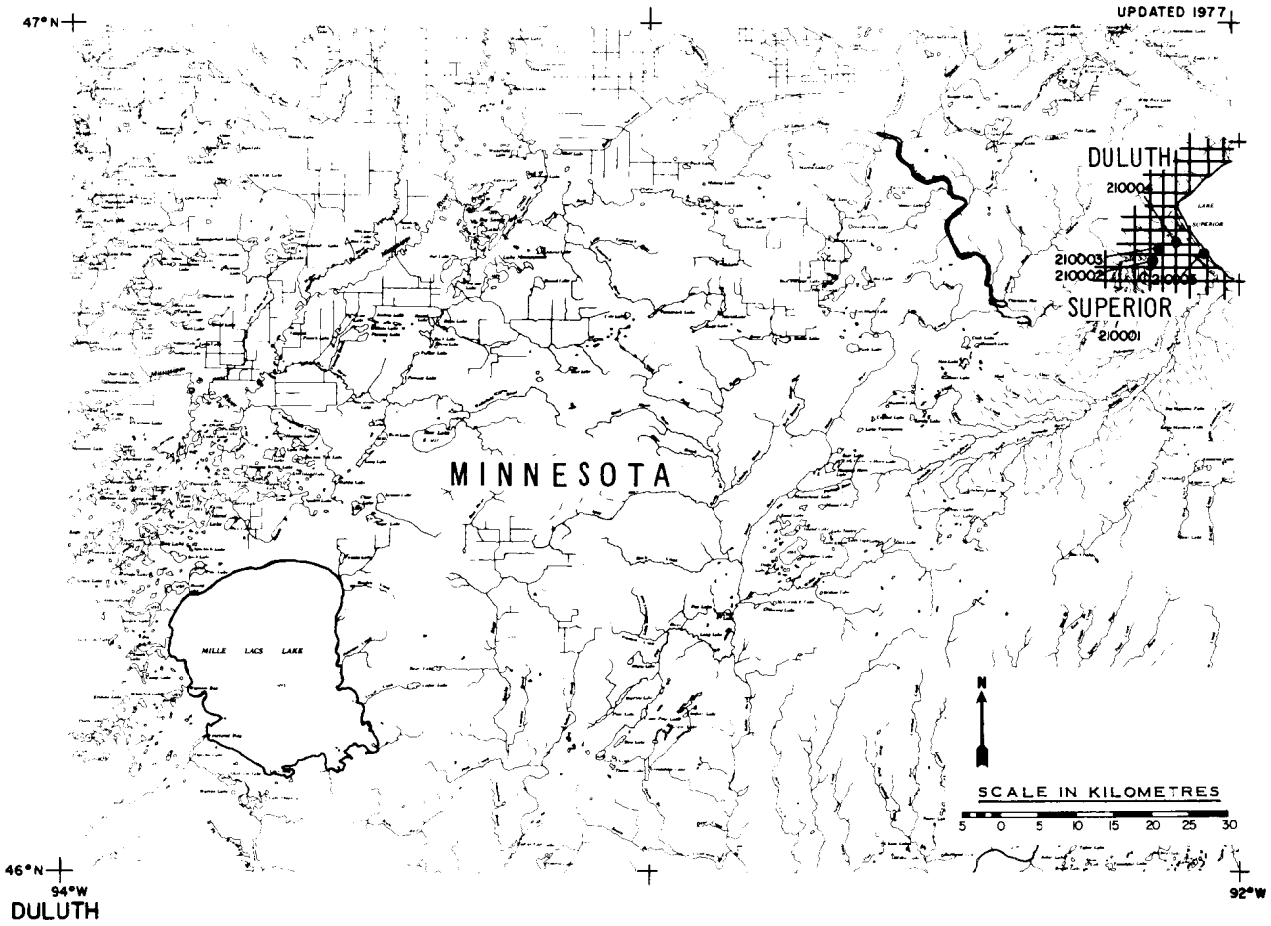
TWO HARBORS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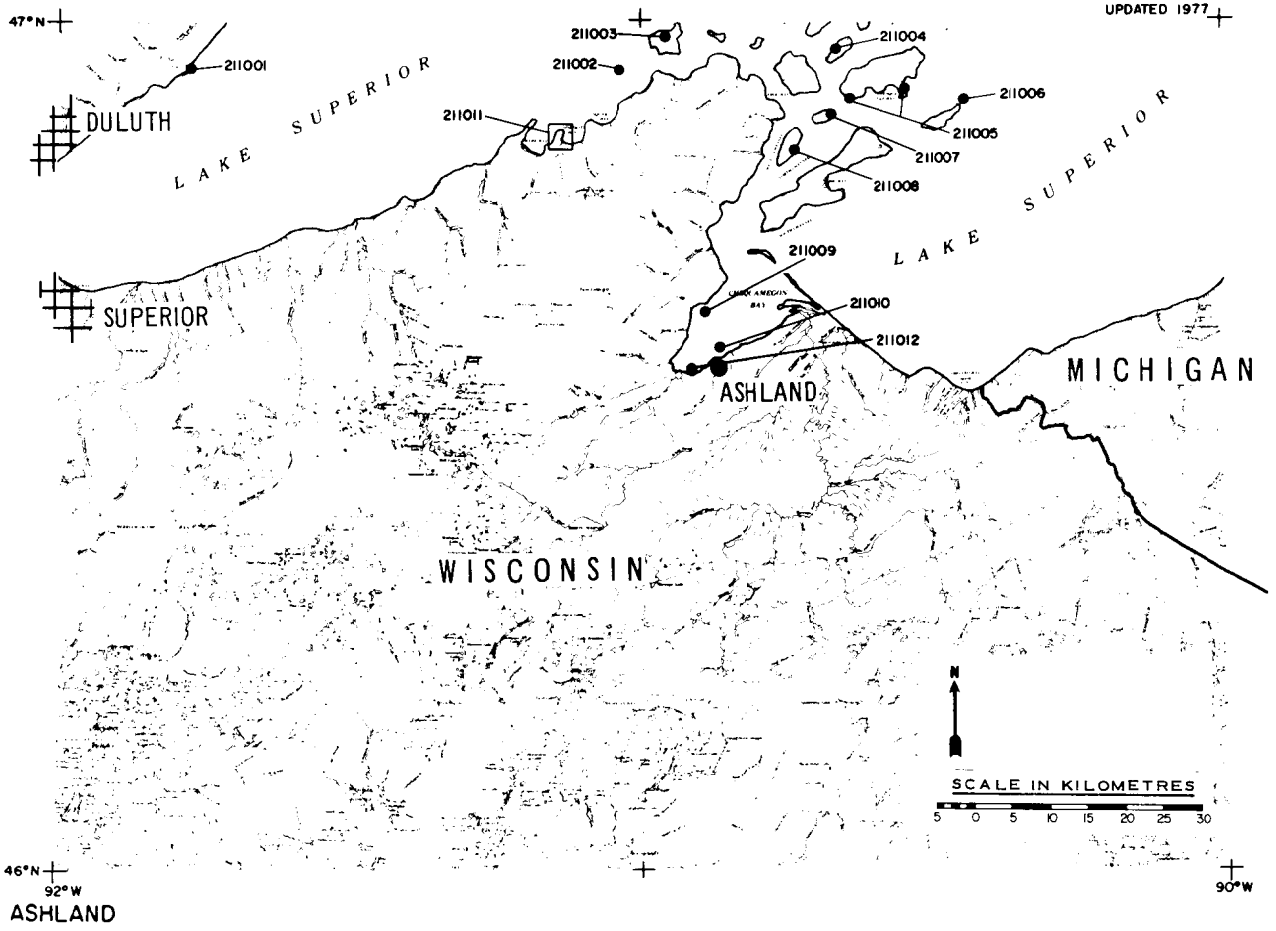
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92°W
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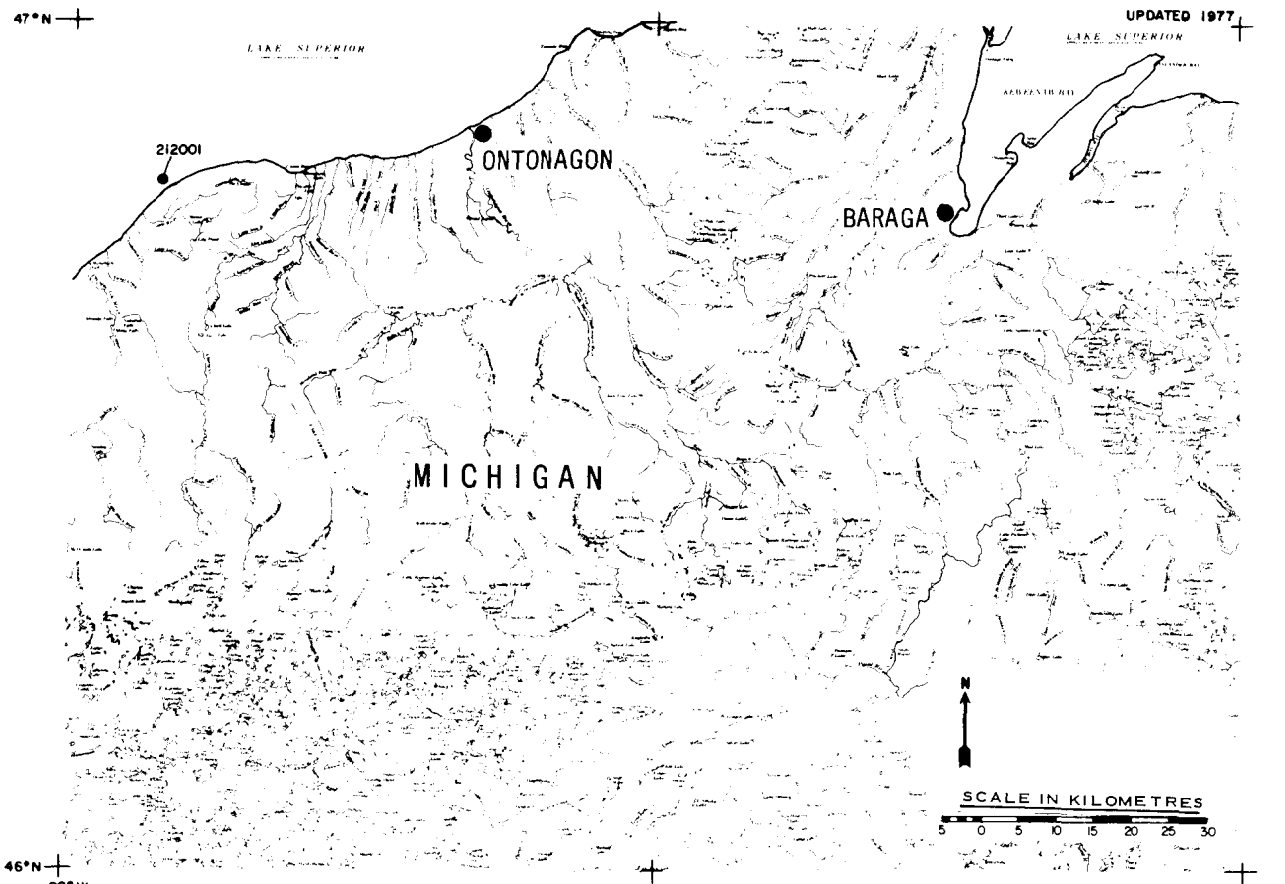
ASHLAND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UPDATED 1977
LAKE SUPERIOR
LAKE SUPERIOR
212001
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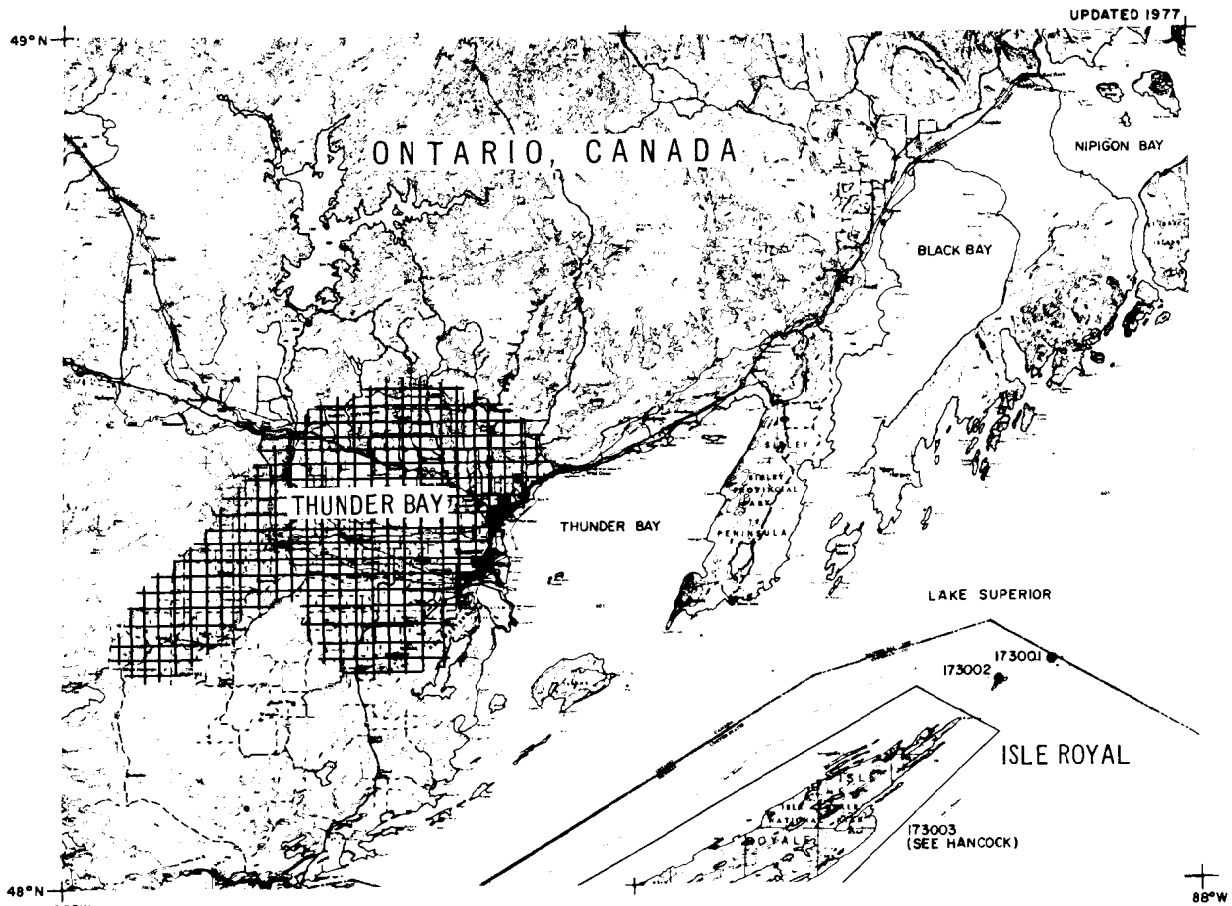
46°N
90°W
88°W

IRON RIVER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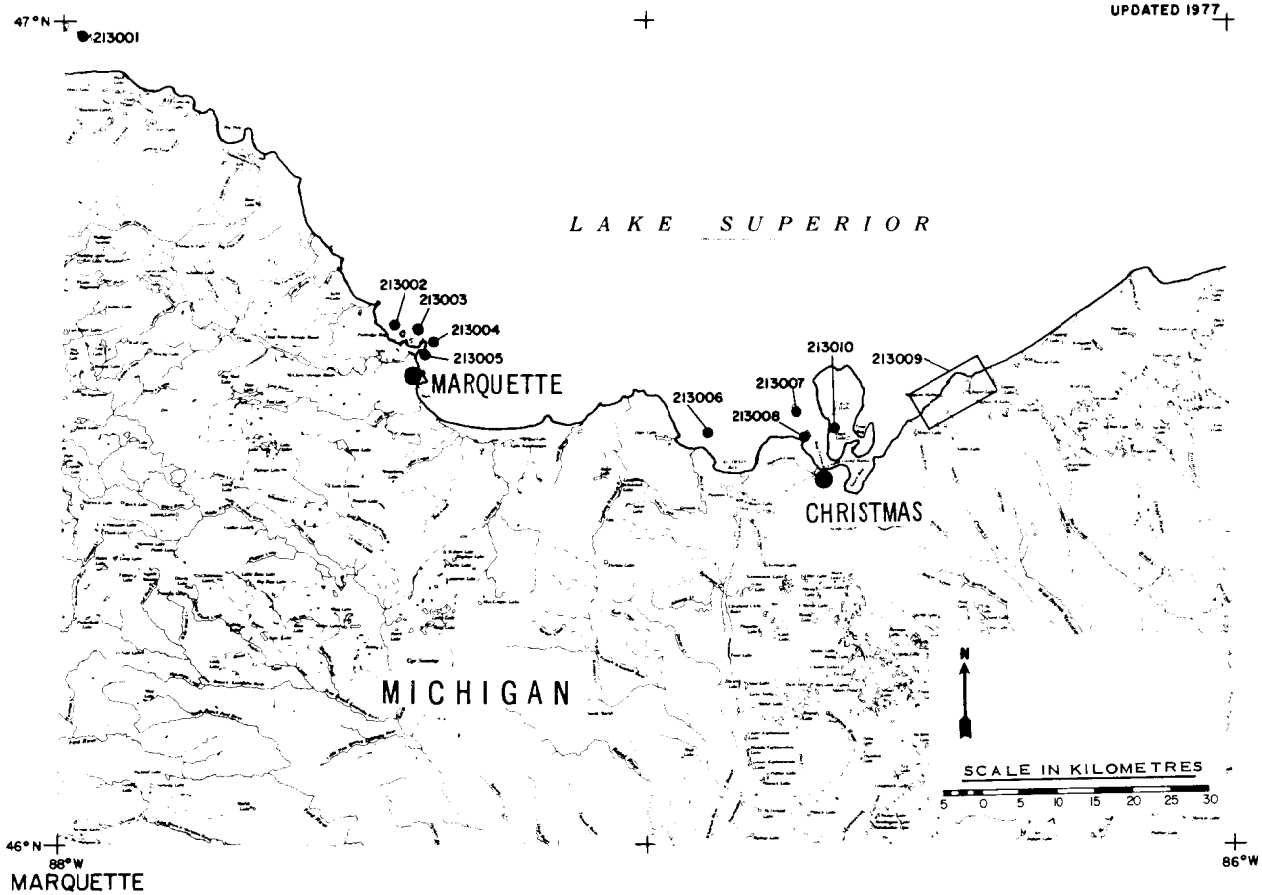
THUNDER BAY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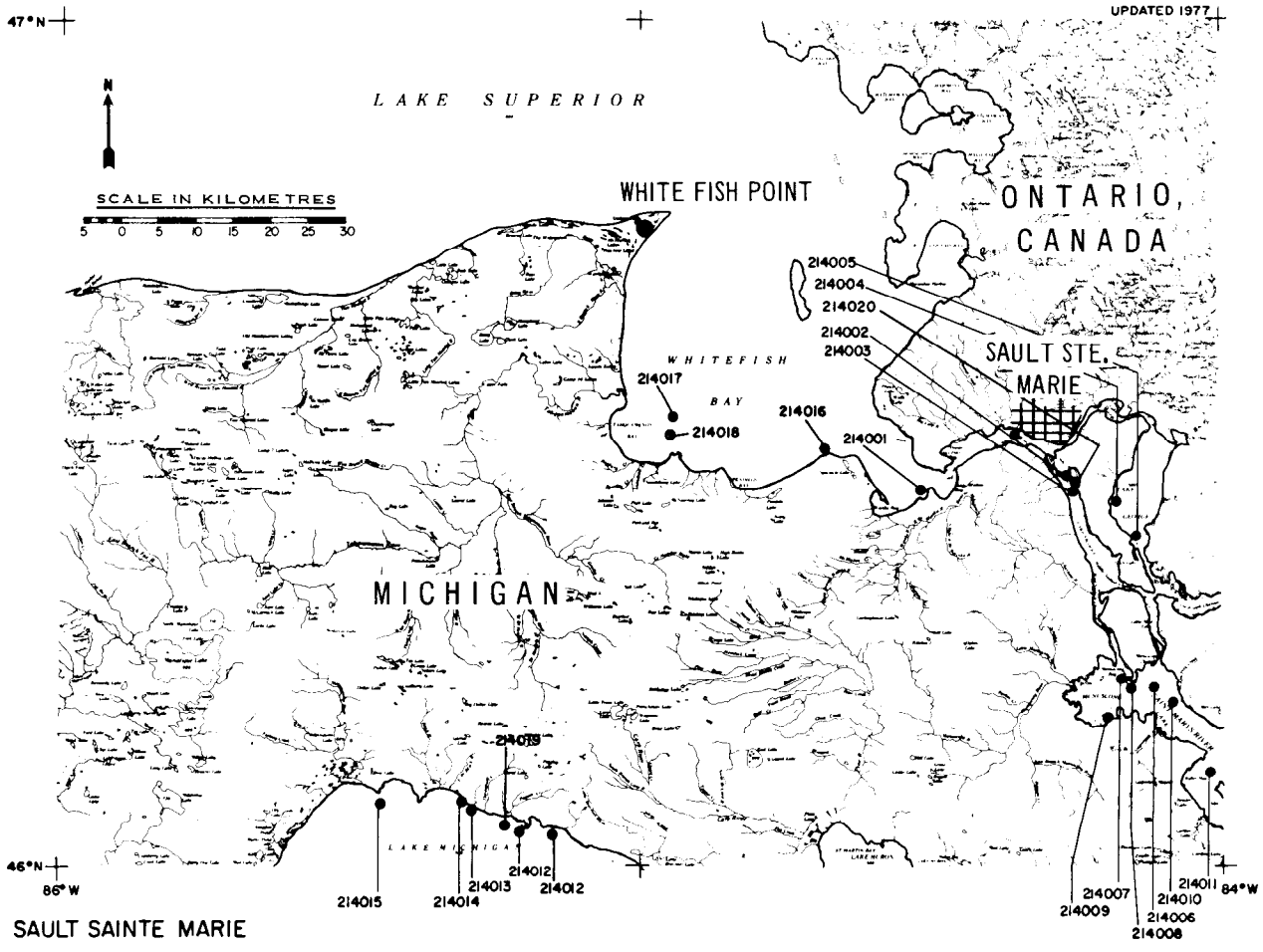
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214016
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MICHIGAN
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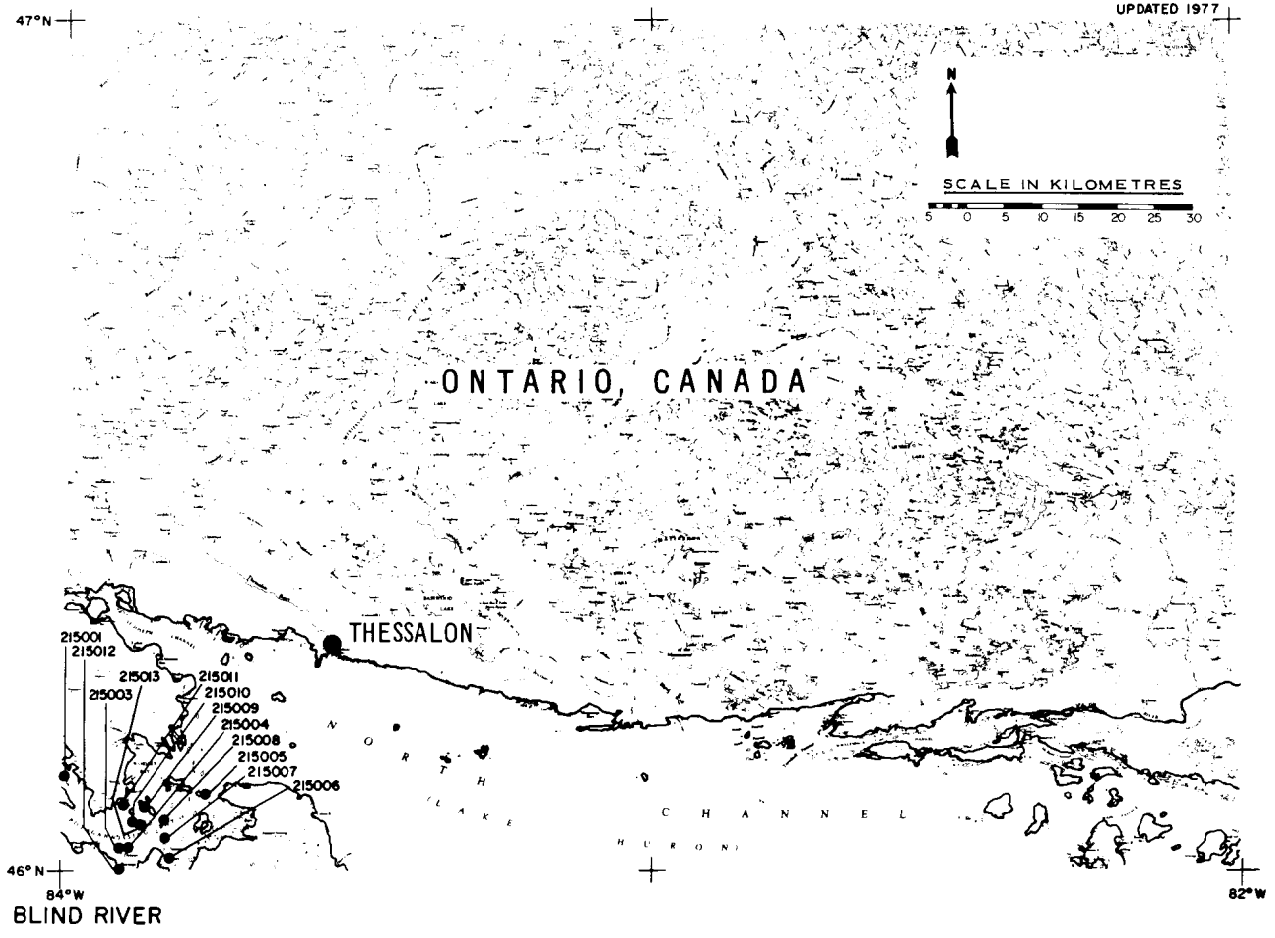
84°W
SAULT SAINTE MARIE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NORTH
CHANNEL
LAKE
HURON
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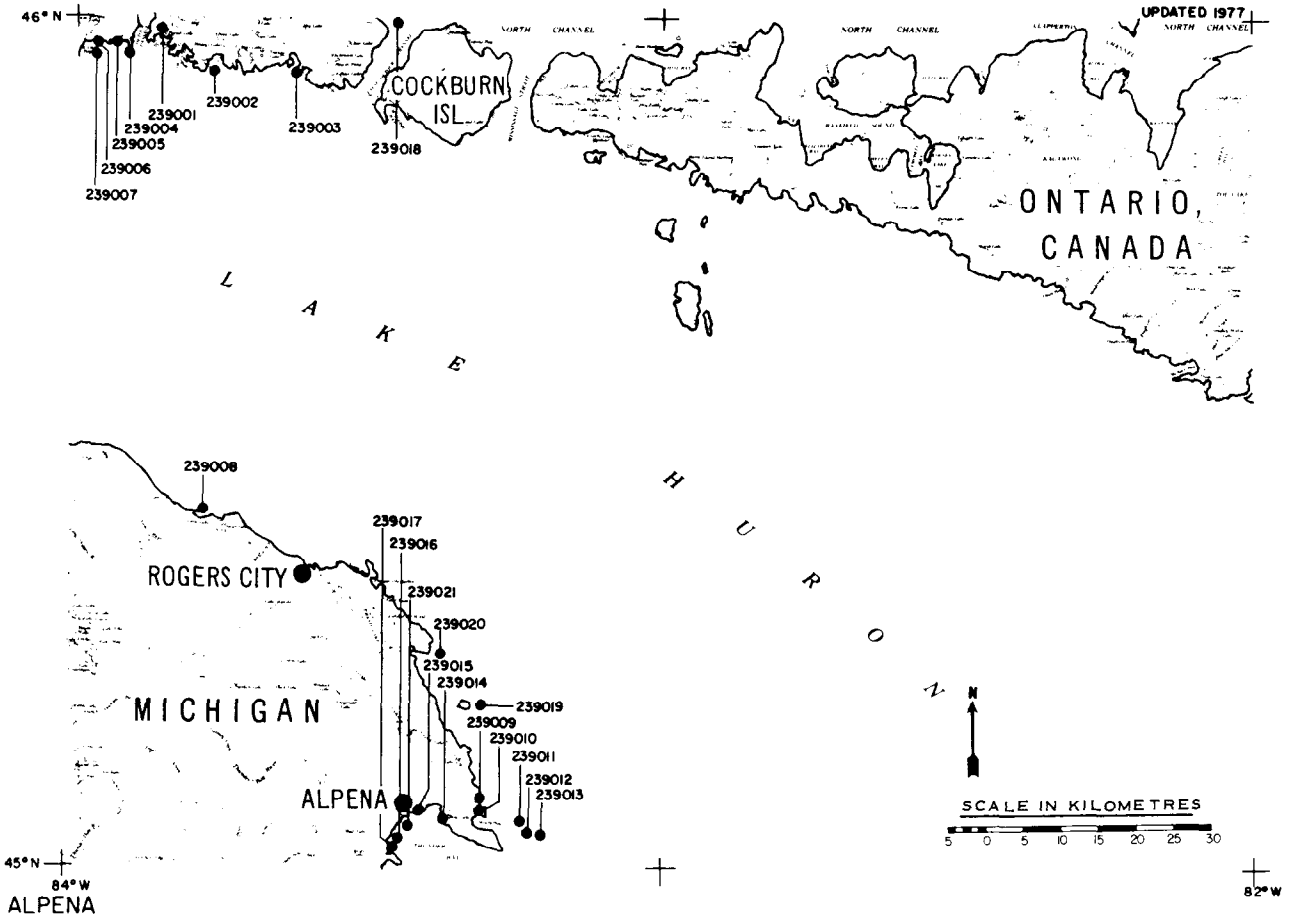
84°W
82°W
BLIND RIVER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L A K E
H U R O N
239008
239017
239016
ROGERS CITY
239021
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239015
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239009
239010
239011
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84° W
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N
SCALE IN KILOMETRES
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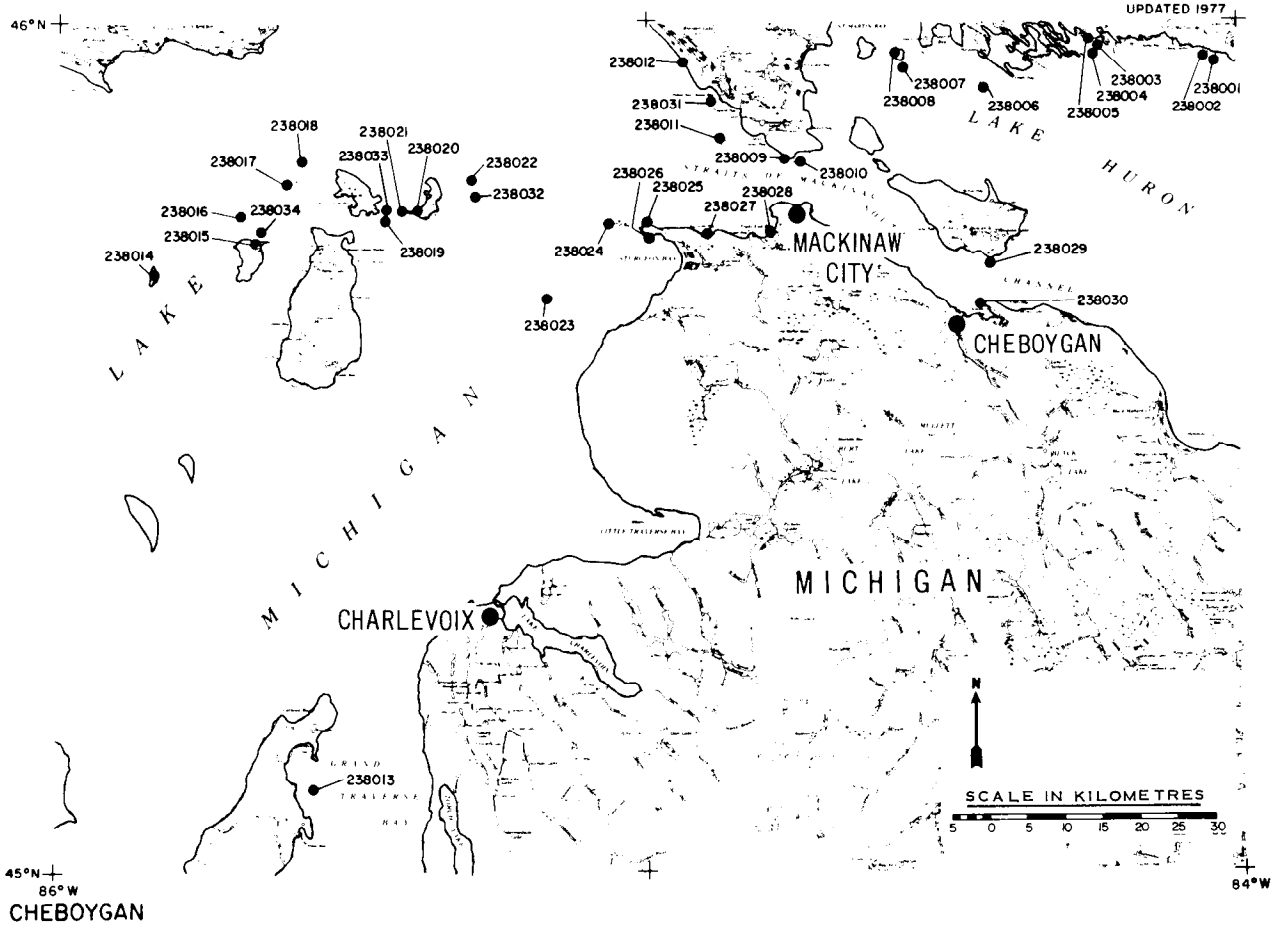
82° W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238032
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238034
238015
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238014
238026
238025
238028
238027
238024
MACKINAW CITY
238029
238023
238030
CHEBOYGAN
LAKE HURON
LAKE MICHIGAN
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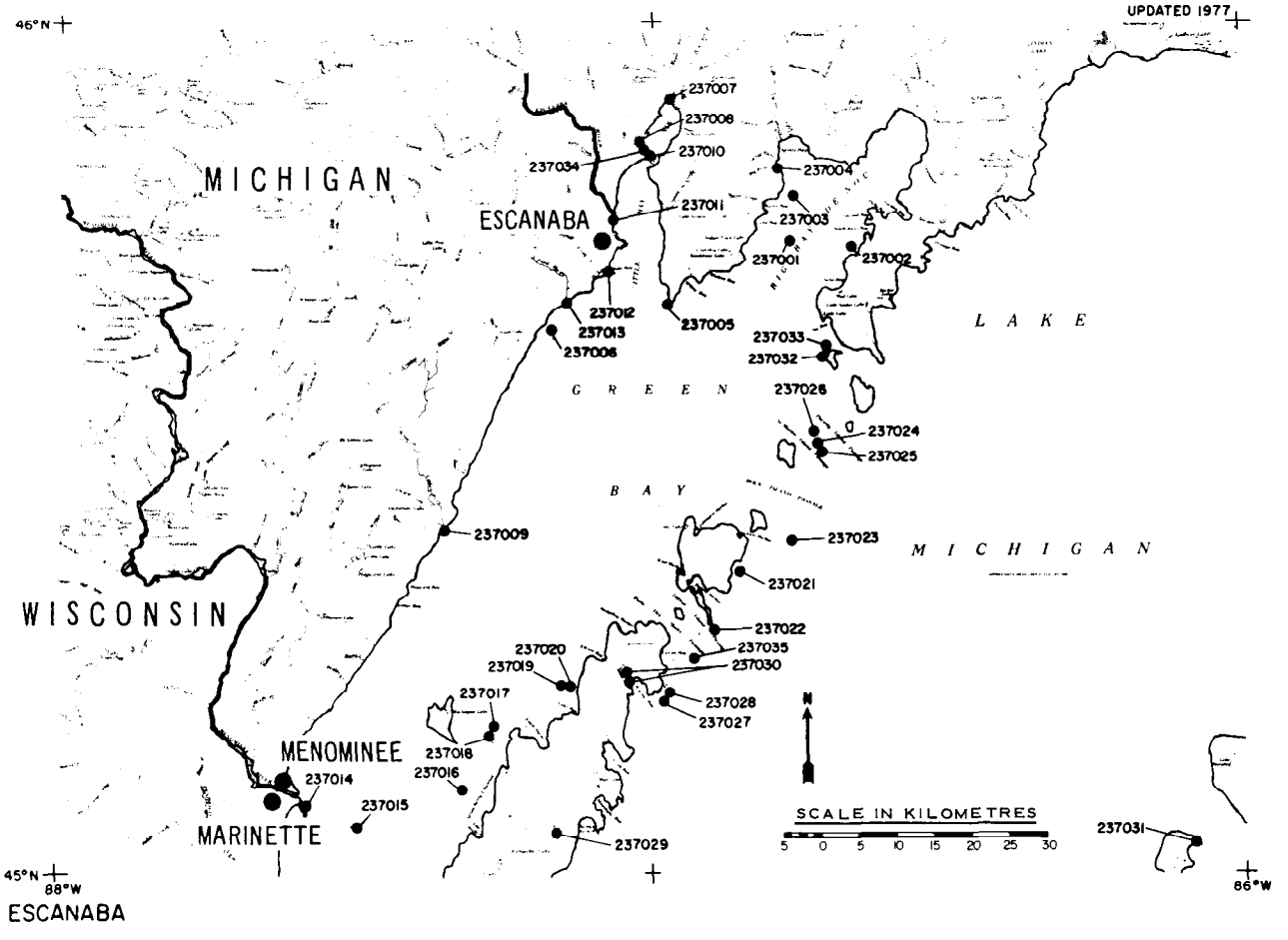
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237032
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G R E E N
237026
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237025
B A Y
237009
237023
M I C H I G A N
237021
WISCONSIN
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86°W
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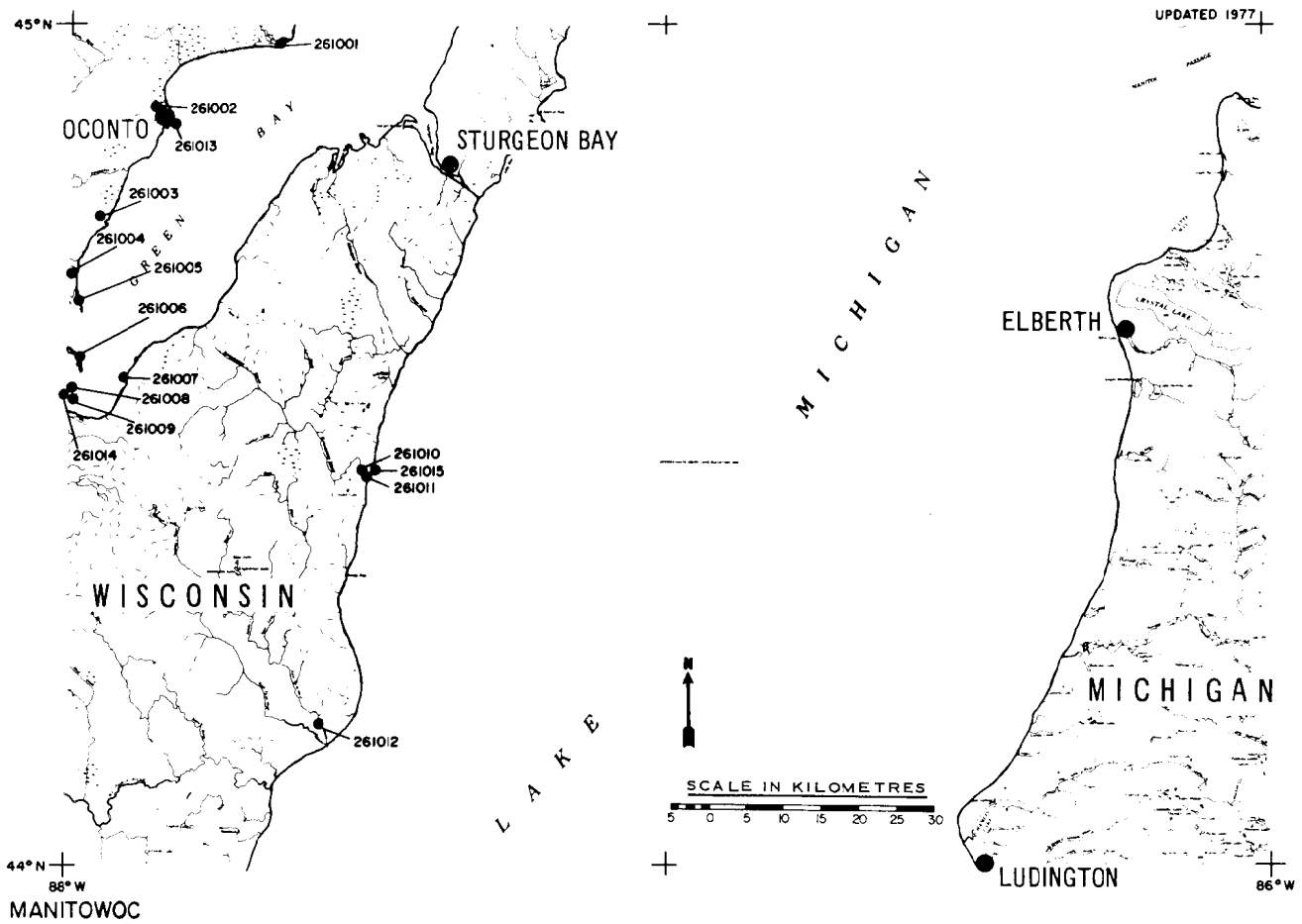
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261013
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261004
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261006
261007
261008
261009
261014
STURGEON BAY
261010
261015
261011
WISCONSIN
261012
LAKE MICHIGAN
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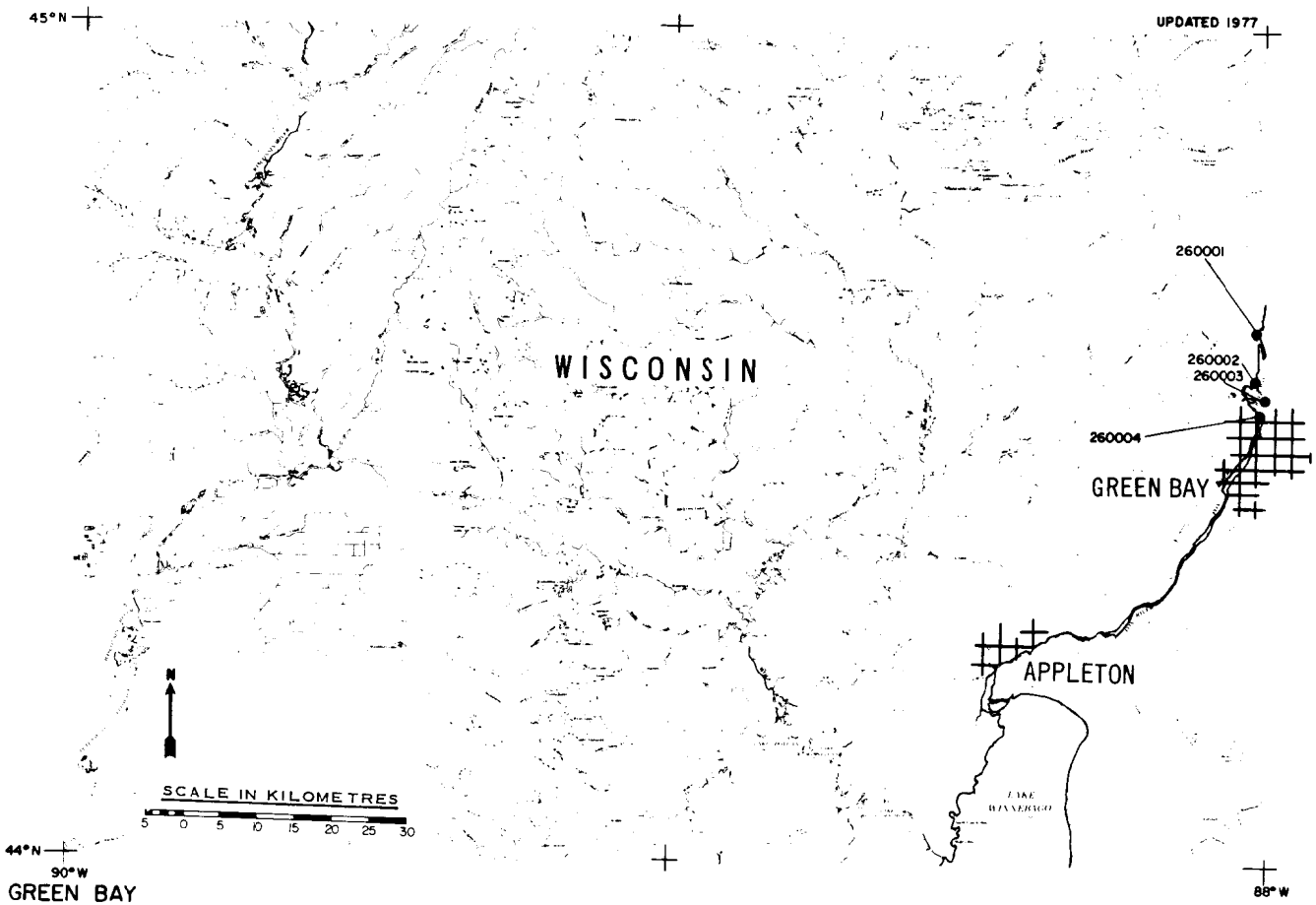
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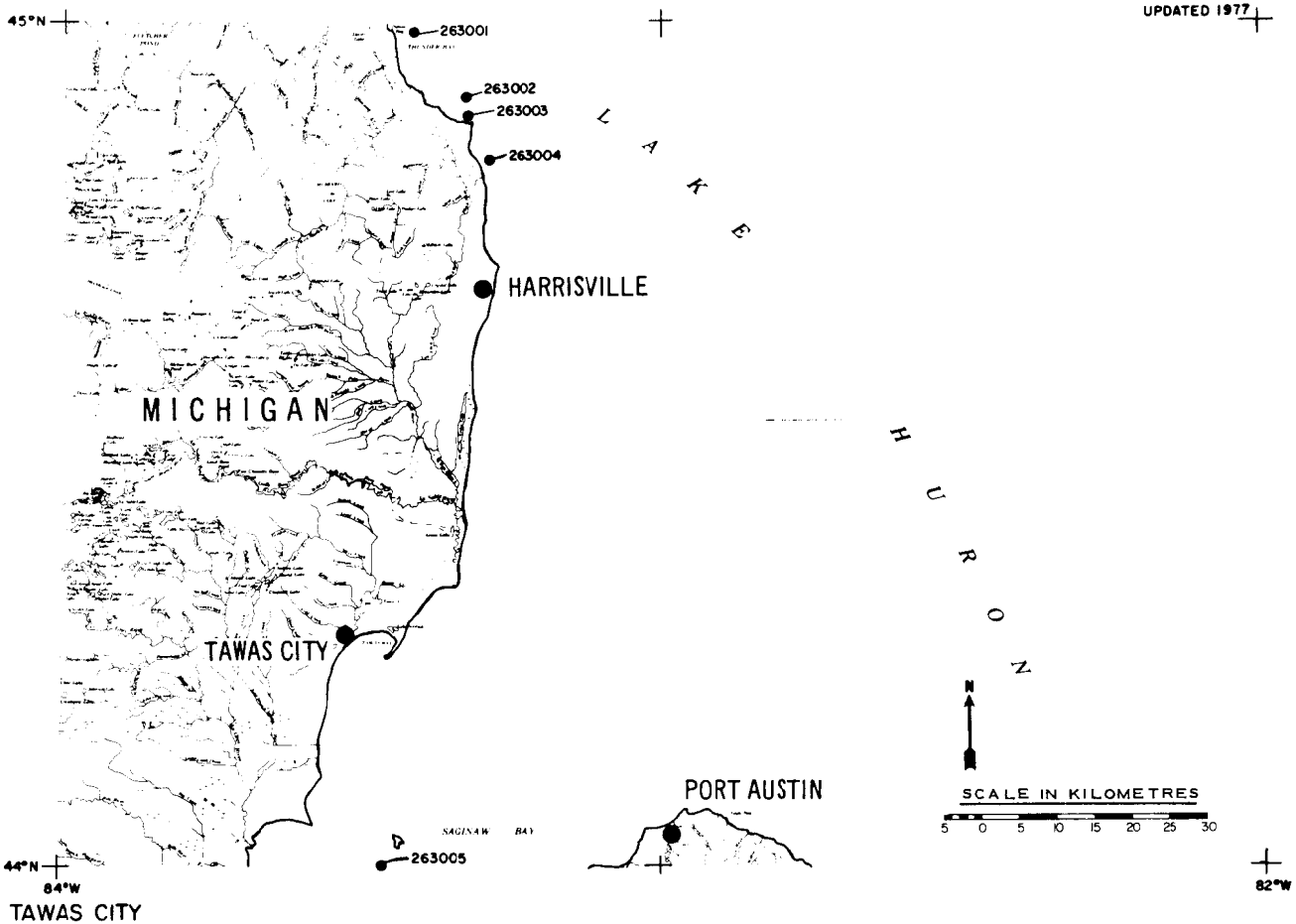
GREEN BAY
88°W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TAWAS CITY
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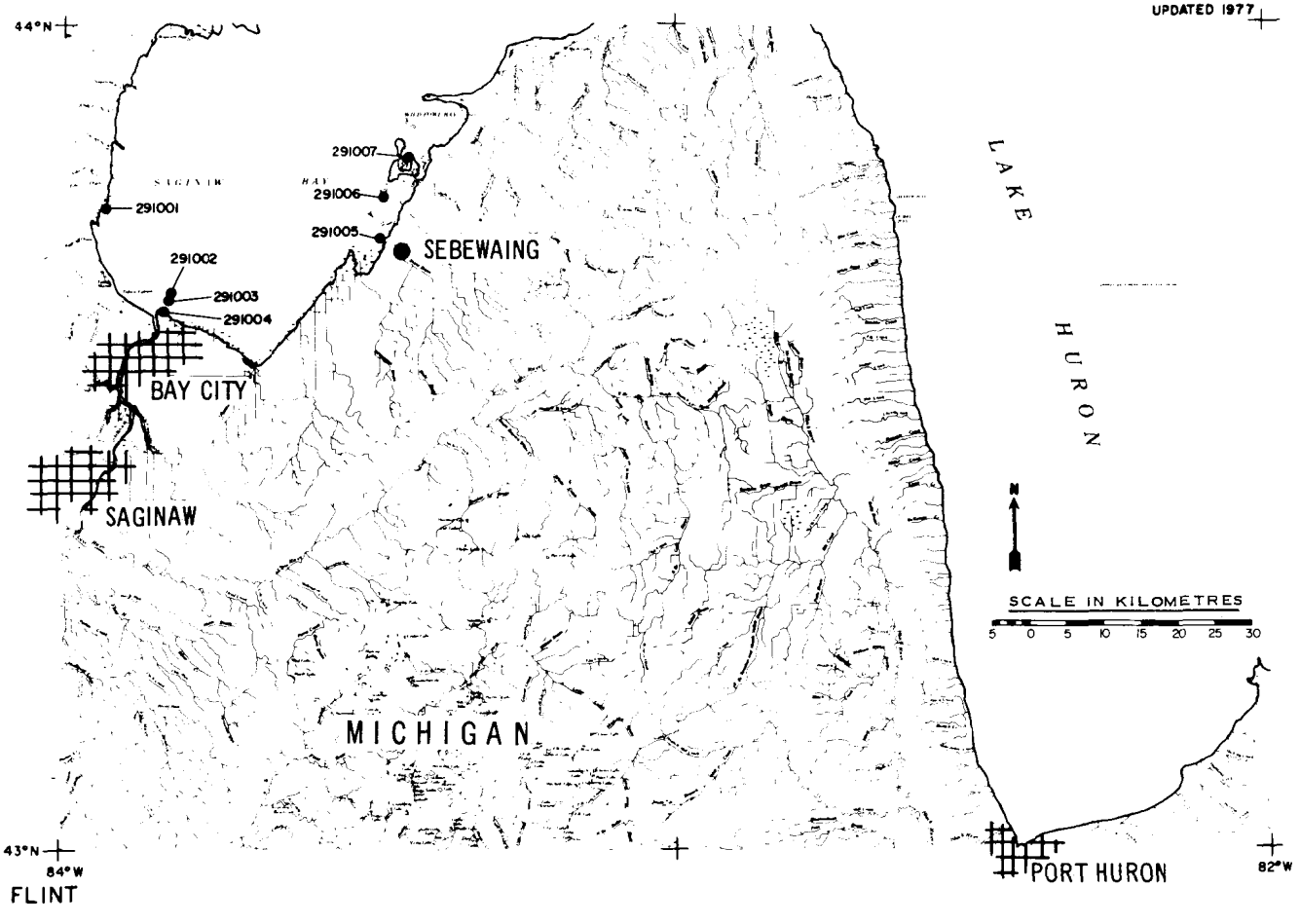
5 0 5 10 15 20 25 30
44°N
84°W
82°W
TAWAS CITY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SAGINAW
LAKE
HURON
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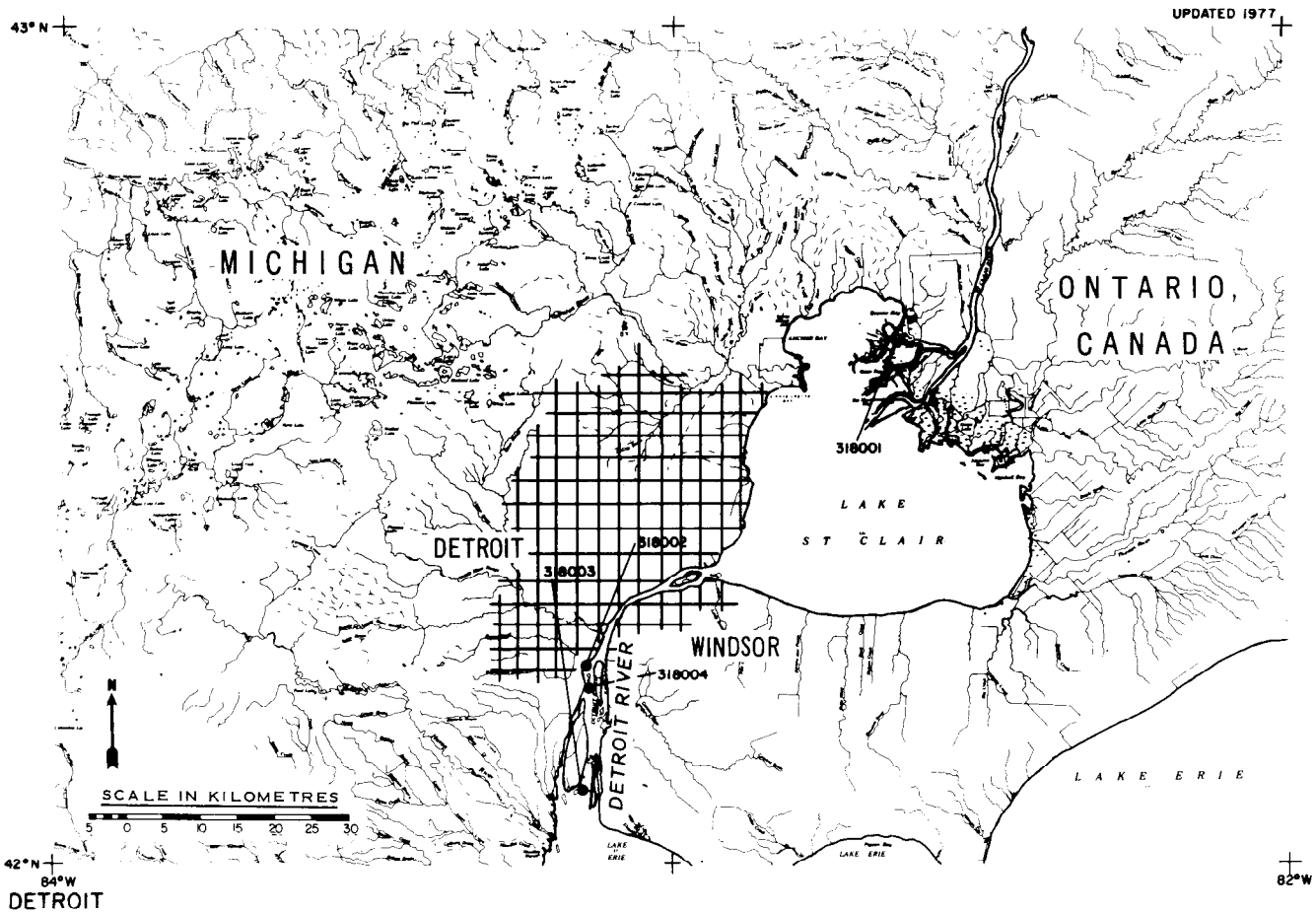
MICHIGAN
43°N
84°W
FLINT
PORT HURON
82°W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ONTARIO,
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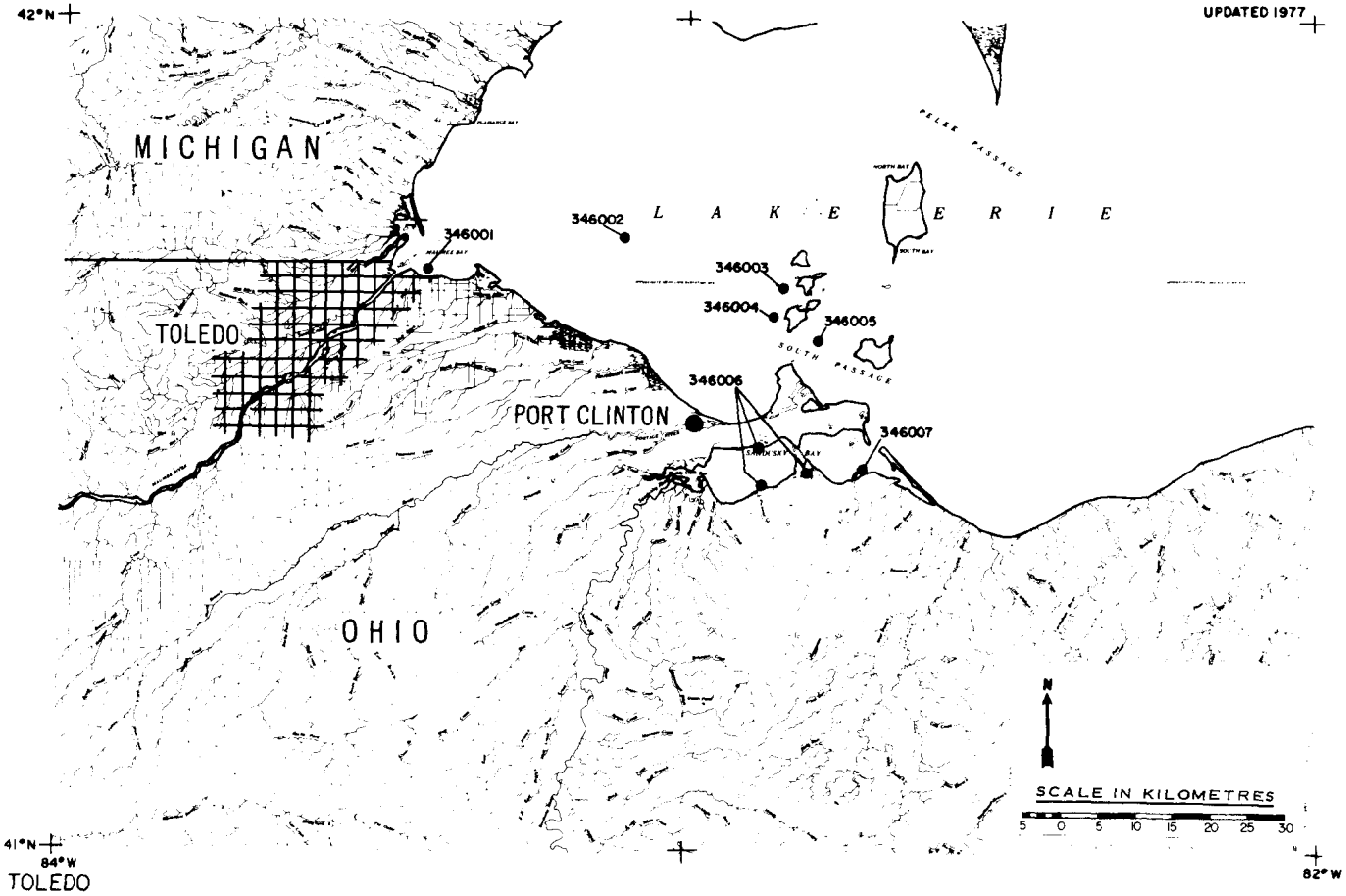
5 0 5 10 15 20 25 30
LAKE ERIE
LAKE ERIE
42°N
84°W
82°W
DETROIT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SOUTH PASSAGE
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PORT CLINTON
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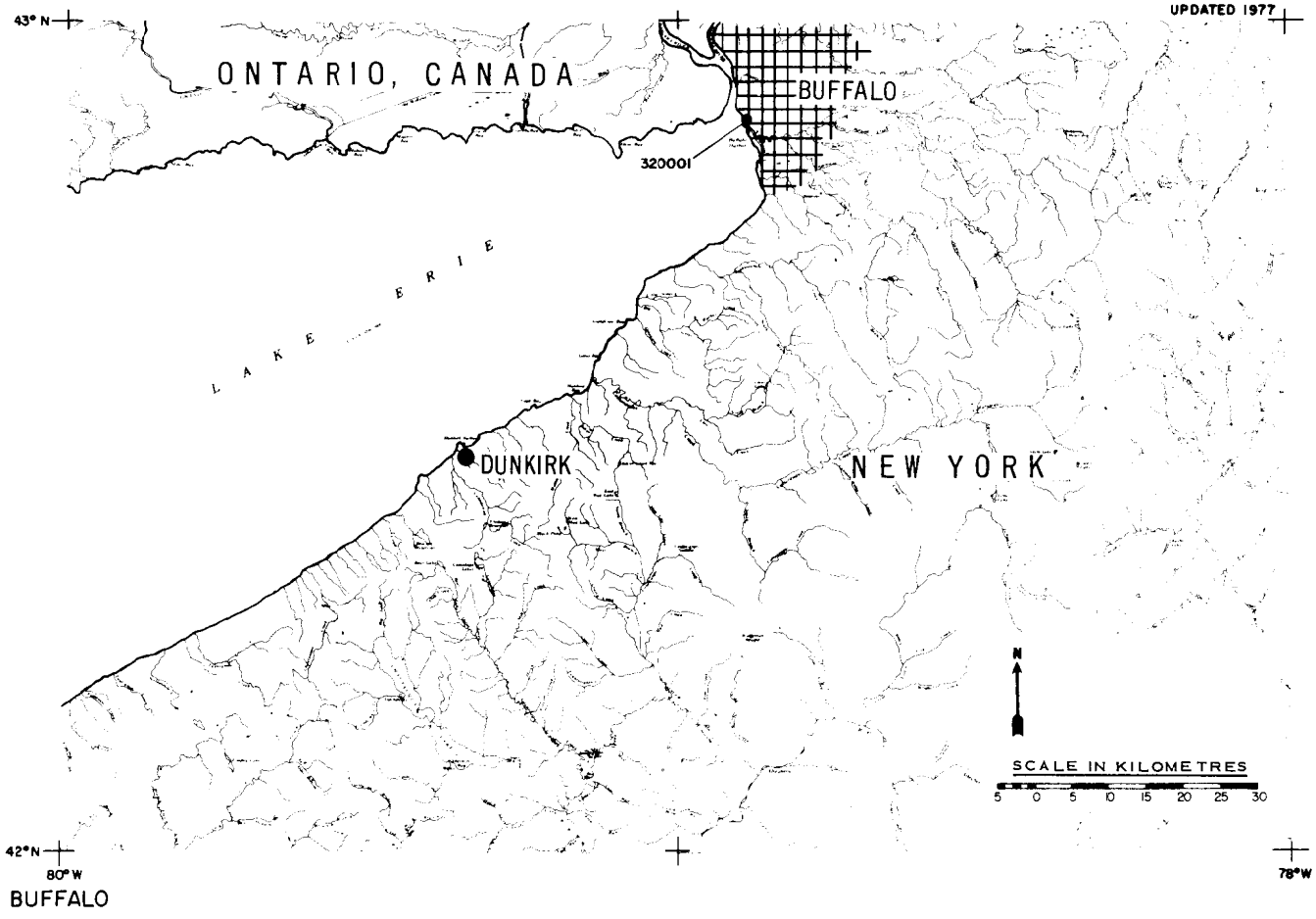
OHIO
N
SCALE IN KILOMETRES
5 0 5 10 15 20 25 30
41°N
84°W
TOLEDO
82°W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BUFFALO
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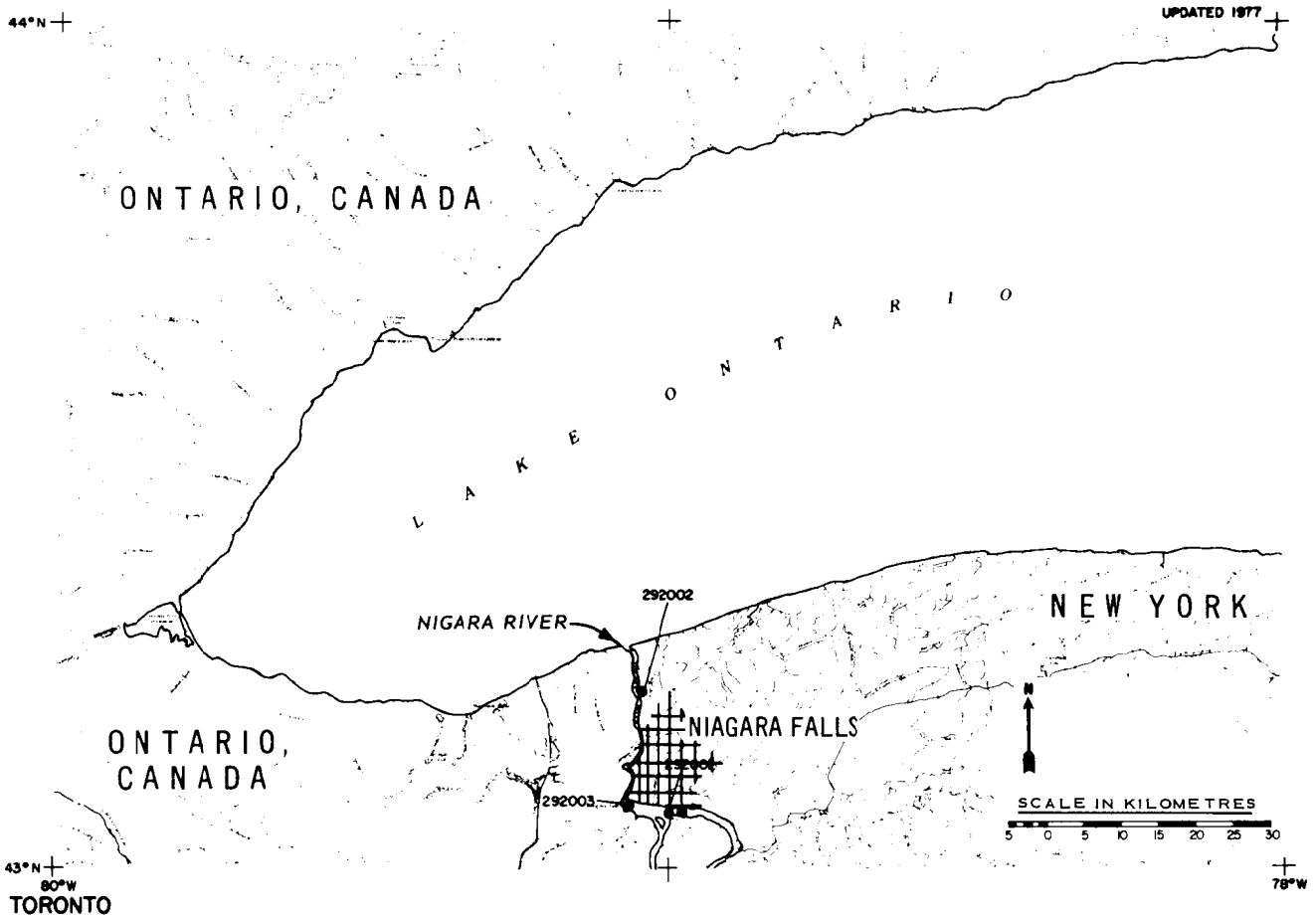
5 0 5 10 15 20 25 30
42° N
80° W
78° W
BUFFALO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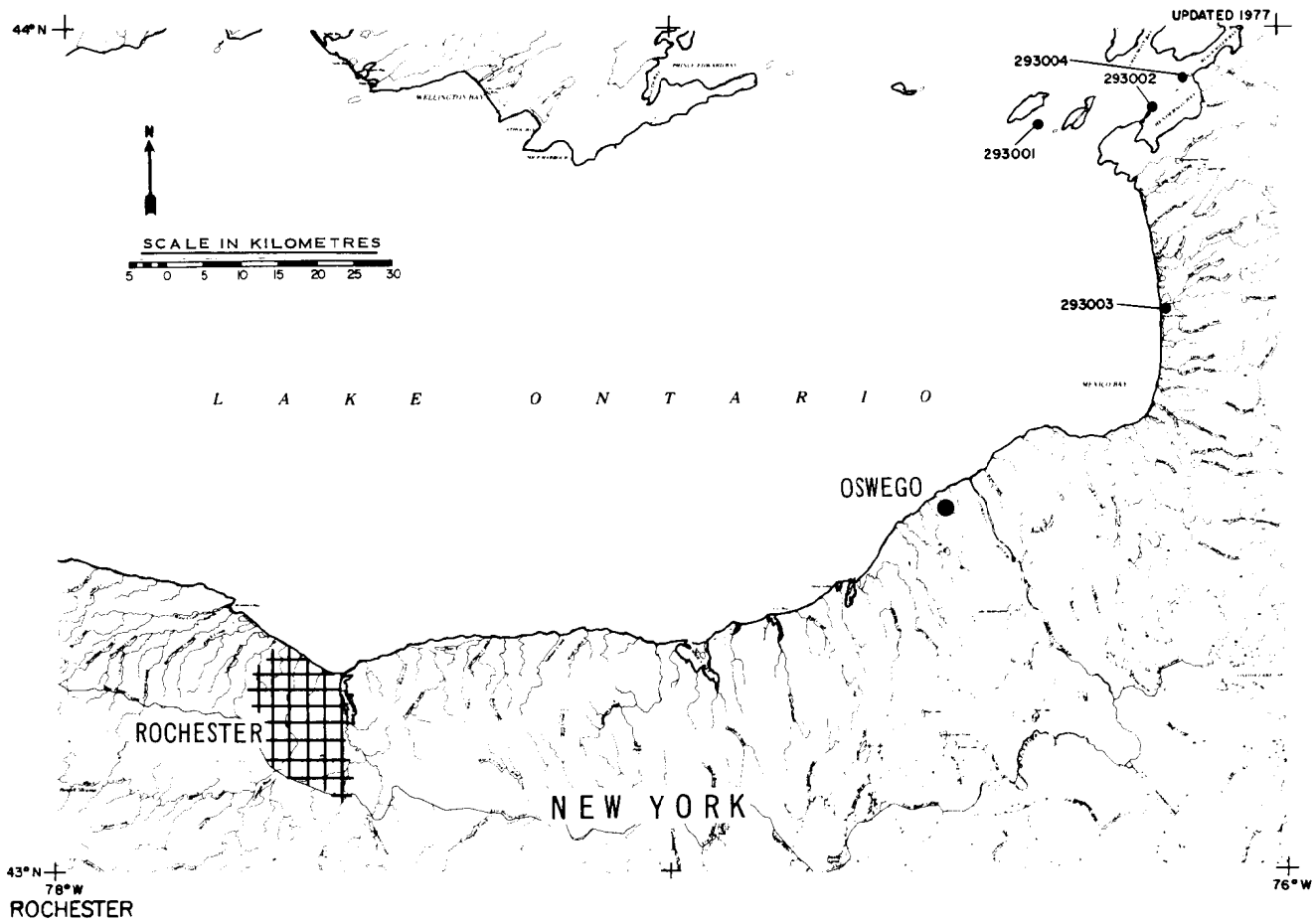
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5 0 5 10 15 20 25 30
L A K E O N T A R I O
OSWEGO
ROCHESTER
NEW YORK
43°N
78°W
ROCHESTER
76°W

APPENDIX B: LIST OF SCIENTIFIC NAMES OF PLANTS USED IN THIS REPORT

SCIENTIFIC NAME	COMMON NAME
FERNS	
Polypodiaceae sp.	Fern
GRASSES	
Agropyron dasystachyum	agropyron
Agropyron repens	witch-grass
Agropyron trachycaulum	agropyron
Ammophila breviligulata	beach grass
Bromus japonicus	brome-grass
Bromus tectorum	brome-grass
Elymus canadensis	wild rye
Glyceria grandis	reed-meadow grass
Hordeum jubatum	squirrel-tail grass
Hystrix patula	bottle-brush grass
Lolium perenne	common darnel
Phleum pratense	common timothy
Phragmites communis	reed
Poa compressa	Canada bluegrass
Poa pratensis	june grass
Poa sp.	meadow grass
HERBS	
Achillea millefolium	common yarrow
Alyssum alyssoides	alyssum
Ambrosia sp.	ragweed

SCIENTIFIC NAME	COMMON NAME
HERBS (continued)	
Aquilegia canadensis	wild columbine
Arctium sp.	burdock
Artium minus	common burdock
Artemisia absinthium	worm wood
Artemisia caudata	worm wood
Asclepias syriaca	common milkweed
Aster sp.	aster
Barbarea vulgaris	common winter-cress
Brassica juncea	Chinese mustard
Brassica nigra	black mustard
Cakile edentula	sea rocket
Campanula rotundifolia	harebell
Capsella bursa-pastoris	pickpocket
Carduus nutans	musk thistle
Centaurea maculosa	spotted star-thistle
Chenopodium album	pigweed
Chrysanthemum leucanthemum	field daisy
Cichorium intybus	common chicory
Cirsium arvense	Canada Thistle
Unidentified crucifer	mustard
Daucus carota	wild carrot
Echinocystis lobata	wild cucumber
Epilobium augustifolium	great willow-herb
Erigeron philadelphicus	fleabane
Eupatorium perfoliatum	thoroughwort
Galium aparine	cleavers

SCIENTIFIC NAME	COMMON NAME
HERBS (continued)	
Galium boreale	northern bedstraw
Geranium robertianum	herb-Robert
Geum virginianum	rough avens
Glecoma hederacea	gill-over-the-ground
Hepatica acutiloba	liverleaf
Heracleum maximum	masterwort
Hieracium aurantiacum	orange hawkweed
Impatiens capensis	spotted touch-me-not
Impatiens sp.	balsam
Ipomoea sp.	morning-glory
Lactuca canadensis	lettuce
Lathyrus japonicus	beach-pea
Leonurus cardiaca	common motherwort
Lepidium campestre	cow-cress
Lepidium virginicum	poor-man's pepper
Linaria vulgaris	butter and eggs
Lychnis alba	white campion
Lythrum salicaria	Spiked loosestrife
Matricaria matricarioides	pineapple-weed
Melilotus alba	white melilot
Melilotus officinalis	yellow melilot
Nepeta cataria	catnip
Oenothera biennis	evening primrose
Parthenocissus quinquefolia	Virginia creeper
Pastinaca sativa	parsnip
Phytolacca americana	poke

SCIENTIFIC NAME	COMMON NAME
HERBS (continued)	
Plantago major	common plantain
Polygonum lapathifolium	smartweed
Potentilla anserina	silverweed
Potentilla arguta	tall cinquefoil
Potentilla norvegica	cinquefoil
Rorippa islandica	yellow-cress
Rubus idaeus var. *strigosus*	raspberry
Rumex acetosella	sheep-sorrel
Rumex crispus	yellow dock
Rumex mexicanus	curly-leafed dock
Silene noctiflora	night-flowering catchfly
Sisymbrium altissimum	tumble-mustard
Smilacina stellata	false Solomon's-seal
Solanum dulcamara	bittersweet
Solidago racemosa	goldenrod
Solidago sp.	goldenrod
Sonchus arvensis	field-sow thistle
Stellaria media	common chickweed
Tanacetum vulgare	common tansy
Taraxacum officinale	common dandelion
Thlaspi arvense	field penny-cress
Tragopogon major	goat's-beard
Trifolium agrarium	yellow clover
Trifolium pratense	red clover
Urtica dioica	stinging nettle

SCIENTIFIC NAME	COMMON NAME
HERBS (continued)	
Verbascum thapsus	common mullein
Vicia americana	vetch
Vitis riparia	river-bank grape
RUSHES AND FALSE RUSHES	
Equisetum sp.	horsetail
Juncus sp.	rush
SEDGES	
Carex sp.	sedge
SHRUBS	
Cornus stolonifera	red-osier dogwood
Juniperus horizontalis	creeping savin
Physocarpus opulifolius	ninebark
Ribes hirtellum	gooseberry
Rhus radicans	poison ivy
Rhus typhina	staghorn sumac
Rosa sp.	rose
Salix interior	sandbar willow
Sambucus canadensis	common elder
Sambucus pubens	red-berried elder
TREES	
Acer negundo	box elder

SCIENTIFIC NAME	COMMON NAME
TREES (continued)	
Acer saccharum	sugar maple
Amelanchier laevis	juneberry
Fraxinus americana	white ash
Morus rubra	red mulberry
Populus balsamifera	balsam popular
Populus deltoides	eastern cottonwood
Populus tremuloides	quaking Aspen
Prunus pumila	sand cherry
Prunus virginiana	choke cherry
Pyrus americana	American mountain ash
Salix amygadaloides	peach-leaved willow
Thuja occidentalis	arborvitae
Prunus americana	plum

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Scharf, William C
Colonial birds nesting on man-made and natural sites in the U. S. Great Lakes / by William C. Scharf, Northwestern Michigan College, Traverse City, Mich. Vicksburg, Miss. : U. S. Waterways Experiment Station ; Springfield, Va. : available from National Technical Information Service, 1978.
136, [189] p. : ill. ; 27 cm. (Technical report - U. S. Army Engineer Waterways Experiment Station ; D-78-10)
Prepared for U. S. Fish and Wildlife Service, Washington, D. C., and Office, Chief of Engineers, U. S. Army, Washington, D. C., under Contract No. USFWS-CE7-255, Coastal Ecosystems Project, Biological Services Program (DMRP Work Unit No. 4F01A)
Monitored by National Coastal Ecosystems Team, Office of Biological Services, U. S. Fish and Wildlife Service, National Space Technology Laboratories, NSTL Station, Miss., and Dredged Material Research Program, Environmental Laboratory, U. S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.
Appendixes C-E on microfiche in pocket.
FWS/OBS-78/15.
References: p. 134-136.

(Continued on next card)

Scharf, William C
Colonial birds nesting on man-made and natural sites in the U. S. Great Lakes ... 1978. (Card 2)

1. Birds. 2. Great Lakes. 3. Habitats. 4. Nesting. 5. Vegetation. I. Northwestern Michigan College. II. United States. Army. Corps of Engineers. III. United States. Fish and Wildlife Service. IV. Series: United States. Waterways Experiment Station, Vicksburg, Miss. Technical report ; D-78-10.
TA7.W34 no.D-78-10